ACRP

REPORT 84

AIRPORT COOPERATIVE RESEARCH PROGRAM

Sponsored by the Federal Aviation Administration

Guidebook for Preparing Airport Emissions Inventories for State Implementation Plans

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

AIRPORT COOPERATIVE RESEARCH PROGRAM

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Guidebook for Preparing Airport Emissions Inventories for State Implementation Plans

KB Environmental Sciences, Inc.
St. Petersburg, FL

Environmental Science Associates, Inc.
San Francisco, CA

Synergy Consultants, Inc.
Seattle, WA

Stonefield Environmental Consulting
Cary, NC

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), Airlines for America (A4A), and the Airport Consultants Council (ACC) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

Once selected, each ACRP project is assigned to an expert panel, appointed by the TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

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NOTICE

The project that is the subject of this report was a part of the Airport Cooperative Research Program, conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council.

The members of the technical panel selected to monitor this project and to review this report were chosen for their special competencies and with regard for appropriate balance. The report was reviewed by the technical panel and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the Governing Board of the National Research Council.

The opinions and conclusions expressed or implied in this report are those of the researchers who performed the research and are not necessarily those of the Transportation Research Board, the National Research Council, or the program sponsors.

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COOPERATIVE RESEARCH PROGRAMS

AUTHOR ACKNOWLEDGMENTS

This *Guidebook* was prepared pursuant to ACRP Project 02-21 "Evaluation of Airport Emissions within State Implementation Plans" by KB Environmental Sciences, Inc. (KBE), Environmental Science Associates, Inc. (ESA), Synergy Consultants, Inc., and Stonefield Environmental Consulting.

Michael Kenney was the Principal Investigator. Carrol Fowler was the Project Administrator. Contributing authors for this *Guidebook* include the following: Michael Ratte and Paul Sanford, both with KBE; Adrian Jones and Michael Arnold with ESA; Mary Vigilante of Synergy Consultants; and David Stonefield with Stonefield Environmental Consulting.

The research team would like to express its gratitude to the members of the ACRP Project Panel for their input throughout this research project. The research team would also like to thank the various airport representatives who participated in this research, including Hartsfield-Jackson Atlanta International Airport (ATL), Denver International Airport (DEN), Las Vegas McCarran International Airport (LAS), and Seattle-Tacoma International Airport (SEA).

FOREWORD

By Lawrence D. Goldstein
Staff Officer
Transportation Research Board

ACRP Report 84 combines a Guidebook with an accompanying interactive tool designed for airport operators and air quality regulators as they prepare the airport emissions inventory component of a State Implementation Plan (SIP). In particular, this Guidebook includes an assessment of the current state of the practice combined with suggestions on how to improve airport emissions inventories, emphasizing key data inputs for aircraft, auxiliary power units (APUs), and ground support equipment (GSE). Consideration is also given to application of future-year forecasts of airport operational levels. The research that led to this Guidebook focused on civilian airports, both commercial service and general aviation (GA). The Guidebook offers three approaches (Basic, Intermediate, and Advanced) for preparation of an airport emissions inventory. Each approach is progressively more complex, requiring increasingly detailed input data that generates greater airport specificity and accuracy. The choice of a particular approach is up to the user as a function of the level of response appropriate to a specific airport, the demands of the facility and the surrounding community, and data availability. For non-hub and GA airports, the accompanying CRP-CD-131 provides an Airport Emissions Estimator Tool that applies to the Basic Approach. In addition, CRP-CD-131 includes the appendixes that accompany this report as well as other project-specific material.

Regulatory agencies, airports, and their consultants will find this Guidebook especially helpful for complying with the Federal Clean Air Act, the National Environmental Policy Act, and other regulations that require documenting air emissions at airports. To meet that objective, the Guidebook provides clear and concise descriptions and procedures on how to compute airport-related emissions for SIPs, ensuring that these emissions are accounted for properly.

Aviation continues to be a growth industry in the United States, and this growth has resulted in an increase in traffic at the nation's major airports accompanied by a corresponding increase in emissions. In addition, as EPA's emission control strategies for other non-aviation sectors take effect, aviation emissions sources could become more pronounced and, as a result, a more significant component of future SIPs. Regulations require that all federal actions be in conformance with applicable SIPs, with the understanding that non-conformance could affect the potential for federal funding of future airport development projects. Improving the ability to generate airport emissions inventories may help improve the process of preparing SIPs and aid in the consideration of future airport improvements.

Guidebook users will find the information particularly useful as they prepare these airport-related emissions inventories for incorporation into SIPs. The proposed procedures apply to airports of every size (small, medium, large) and function (commercial, GA) and to users of every skill level. This Guidebook and accompanying Airport Emissions Estimator Tool can help to assure users that their airport emissions inventories are up to date and in a form that is appropriate for SIPs. As a result, both airports and regulatory agencies will benefit.

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

CHAPTER 1

Why Use This Guidebook?

1.1 Why A Guidebook?

Long-standing concerns over the effects of air pollution on human health and the environment have made the intersection between aviation and air quality a matter of enduring importance to both airport operators and air quality regulatory agencies alike. On the one hand, airports serve vital civic and economic functions by transporting people and cargo safely and efficiently across the country and throughout the world. On the other hand, air quality regulatory agencies mandate that ambient (i.e., "outdoor") air quality conditions throughout the country meet United States Environmental Protection Agency (U.S. EPA's) air quality standards (called the National Ambient Air Quality Standards, or NAAQS), both now and in the future.

In accordance with the federal Clean Air Act (CAA), areas that do not meet the NAAQS are classified as *nonattainment* areas. As the blueprint to demonstrating compliance, or *attainment*, with the NAAQS, State Implementation Plans (SIPs) specify the emissions limits and measures deemed necessary to bring nonattainment areas into compliance.

Because airports are among the numerous, and potentially significant, sources of emissions in most nonattainment areas, having their emissions identified and properly accounted for SIPs is critical (this also applies to attainment/maintenance or maintenance areas, as discussed in Chapter 2). This *Guidebook* is designed to help ensure that airport-related emissions are properly represented in SIPs and comply with the General Conformity Rule (Section 176(c) of the CAA).

SIPs, General Conformity, and Airport Emissions Q&A's.

Question 1: What is a State Implementation Plan (SIP)?
Answer: A strategy for bringing areas that do not meet national ambient air quality standards into compliance.

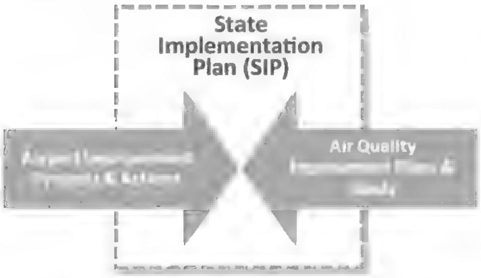
Question 2: What is the General Conformity Rule?
Answer: A provision of the Clean Air Act that requires emissions from airport projects/actions to conform to SIPS.

Question 3: What is an airport emissions inventory?
Answer: A quantification contained in SIPs of air pollutant emissions associated with airport sources.

Question 4: Why use this *Guidebook*?
Answer: To ensure that airport-related emissions conform to SIPs and comply with the General Conformity Rule.

1.2 What Is the Association between Airports and Air Quality?

The association between aviation and air quality within SIPs is growing in importance as (1) airport operators seek to improve and expand their facilities to accommodate the projected growth in air passenger levels and aircraft operations and (2) air quality regulatory agencies strive to fulfill the provisions of the SIP and meet the NAAQS within approaching attainment deadlines and, in some cases, with stricter air quality standards. And under the General Conformity Rule, federal agencies, such as the Federal Aviation Administration (FAA), are prohibited



The junction where aviation and air quality most often intersect is within State Implementation Plans (SIPs).

from engaging in, providing financial assistance for, licensing or permitting, or approving any activity that does not conform to an approved SIP.

1.3 What Is the Purpose of the Guidebook?

Based on the information discussed above, the primary objectives of this *Guidebook* are aimed at ensuring airport-related emissions are properly accounted for in SIPs prepared under the federal CAA for designated non-attainment and maintenance areas and that these airport emissions inventories are prepared as effectively, consistently, and accurately as possible. In this way, airport improvement projects and actions will also meet the requirements of the CAA's General Conformity Rule.

Importantly, this *Guidebook* includes guidance on how to prepare an emissions inventory for aircraft, auxiliary power units (APUs), and ground support equipment (GSE). Guidance on how to prepare emissions inventories for on-road motor vehicles, construction activities, or stationary sources is not provided here as these sources are typically addressed by air quality agencies separately and are not included in airport emissions inventories for SIPs.

1.4 Who Should Use This Guidebook?

This *Guidebook* was specifically prepared for use by the two principle stakeholders involved in preparing airport emissions inventories for inclusion in SIPs: (1) airport operators and (2) air quality regulatory agencies. These participants, their responsibilities and their common interests in ensuring that airport-related emissions are properly represented and accounted for in SIPs are specified in Figure 1-1.

In addition to the two stakeholders mentioned in Figure 1-1, others include the EPA, the FAA, non-governmental organizations, and anyone else with an interest in ensuring that the nation's airports are continually modernized while safeguarding the nation's air quality.

Guidebook Objectives

The principal objectives of this *Guidebook* are four-fold. To help ensure that:

- Growth in the aviation sector is not constrained due to air quality regulations;
- Airport emissions are properly accounted for in SIPs, taking into account the inherent uncertainty in future-year forecasts;
- Airport emissions inventories are prepared in the most effective, consistent and accurate manners possible; and
- Airport projects and actions meet the requirements of the CAA General Conformity Rule.

1.5 Problems Solved by Using This Guidebook

To better understand why it is important that airports are accurately represented in SIPs, a basic understanding of the problems and challenges encountered by airport operators and air quality regulatory agencies is necessary. Evaluated during the initial stages of this research project, this information and experience reconfirmed the need for this ACRP initiative and served as guideposts for the preparation of this *Guidebook.*

Based on this research, there are seven issues, or themes, that characterize the primary constraints or impediments to ensuring that airport emissions are properly and accurately represented in SIPs. Addressed individually below, these challenges can be alleviated altogether or significantly minimized with the aid of this *Guidebook.*

- **Promotes Stakeholder Coordination**—Airports represent a complex mix of air emissions sources. Consequently, airport-related emissions

Airport Operators	Air Quality Regulatory Agencies
• **Who:** Airport owners, operators, and their representatives (e.g., consultants and contractors). • **What**: Among the emission source categories included in SIPs, airports represent a comparatively small percentage but encompass a unique assembly of mobile sources including aircraft, APUs, and GSE. • **Why**: Airport operators are well incentivized and uniquely positioned to ensure that airport emissions are properly accounted for in SIPs—especially when the General Conformity Rule must be met.	• **Who:** State, regional, and/or local air quality regulatory and planning agencies involved in preparing and updating SIPs. • **What**: Involved in the computing of emissions inventories for all emissions sources within non-attainment or maintenance areas and formulating the necessary SIP emission reduction strategies to meet the NAAQS. • **Why**: Regulatory agencies are well incentivized and uniquely positioned to ensure that all emissions sources are properly represented and accounted for in SIPs (including airports).

Figure 1-1. Principal Guidebook users.

are comparatively more difficult to quantify than most other sources addressed in SIPs. This uniqueness requires the exchange of information and data that can be effectively achieved by coordination between the airport operators and the air quality regulatory agencies that prepare SIPs.

- **Ensures All Airports Are Included in SIPs**—The research team found that the vast majority (i.e., 70 percent) of the currently and historically approved SIPs specifically named at least one airport, while the remaining SIPs (i.e., 30 percent) only referred to airports in the generic sense and combined all airport emissions together. This oversight makes it difficult to segregate emissions between multiple airports located in the same nonattainment (or maintenance) area, a task that could be required under the General Conformity Rule, and compounds the difficulty in ensuring that all airports are accurately accounted for in an SIP.
- **Identifies Appropriate Emissions Sources to Include in SIPs**—The research team also found that nearly all (i.e., 99 percent) of currently and historically approved SIPs included aircraft emissions, but only one-third included estimates of emissions from other airport sources such as APUs and GSE. As a result of these omissions, airport-related emissions were not always fully accounted for in the SIPs.
- **Applies Reasonable Operational Data When Computing Airport Emissions**—Airport emissions inventories are computed based on a wide assortment of aviation, economic, and population data. The variations in these key inputs or a lack of understanding of the effects of important variables can produce airport emissions inventories in SIPs that are inconsistent, out-of-date, and inaccurate compared to actual conditions.
- **Use Consistent Methods When Preparing Airport Emissions Inventories**—About half of the SIPs reviewed by the research team cited the FAA Emissions and Dispersion Modeling System (EDMS) as the source of airport emissions data with the balance using other sources and methods to prepare the emissions inventory. Because the FAA requires airports to use EDMS when conducting air quality assessments, this inconsistency leads to potentially conflicting and incomparable results between different airports and SIPs (i.e., the "apples and oranges" analogy).

Key Point: Because of social, technological, and economic uncertainties, forecasts of future-year airport operations are approximate. This *Guidebook* recognizes and suggests provisions for this *limitation*.

Keys to Improving How SIPs Account for Airport Emissions

- Coordination Between Airport Operators and Regulatory Agencies
- Better Identification of Airports in SIPs
- Inclusion of Appropriate Airport Sources
- Application of Reasonable Operational Data
- Use of Consistent Methods and Models
- Increase of Levels of Accuracy
- Inclusion of Supporting Documentation
- Accounting for Future-Year Uncertainties

- **Increases Levels of Accuracy of the Emissions Estimates**—State regulatory agencies require emissions inventories in SIPs to contain sufficient details (and levels of accuracy) to enable the identification of the emission reductions necessary to meet the NAAQS. In contrast, airport emissions inventories developed in support of FAA General Conformity Determinations and/or National Environmental Policy Act (NEPA) compliance documents often require more detailed information and greater accuracy than the regulatory agencies need for the preparation of SIPs.
- **Provides Supporting Documentation for the Airport Emissions Inventory**—The technical details, documentation, and backup materials developed in support of the airport emissions inventory were largely unavailable, of insufficient detail, or incomplete in many of the SIPs researched in support of this *Guidebook.* This omission makes it difficult to verify the results and to conduct subsequent General Conformity Applicability Analyses and Determinations for airports.

Taken individually, most of these issues are mainly attributable to the inherent differences in the approaches, needs, and experiences of the two primary SIP stakeholders (i.e., airports and air quality agencies). However, when combined with one another or occurring as a whole, they constitute potential obstacles to ensuring that airport-related emissions are properly accounted for in SIPs and that the requirements of the CAA General Conformity Rule can be met.

Connecting the Stakeholder Dots

- ***Common Interests***—As the two principal stakeholders of this *Guidebook,* airport operators and air quality regulatory agencies have a common interest in ensuring airport emissions are properly accounted for in SIPs.
- ***Individual Goals***—Airport operators have the obligation to service air passenger and cargo demands. Air quality agencies are mandated to prevent the deterioration of air quality.
- ***Mutual Benefits***—In non-attainment or maintenance areas, these goals may seem to be in conflict. However, with the use of this *Guidebook,* both airports and agencies will achieve mutually beneficial outcomes.

1.6 Benefits of Using the Guidebook

As noted previously, this *Guidebook* is purposely designed for use by the two primary stakeholders most capable of ensuring that airport-related emissions are properly and accurately represented in SIPs: (1) airport operators and (2) air quality regulatory agencies. However, the FAA, airlines, airport tenants, and aviation consultants also play important roles in this process. Table 1-1 outlines the benefits to using the *Guidebook.*

How the *Guidebook* is used will depend in large part on the expertise of the users. In some cases, it is expected that the users possess a high level of knowledge and experience related to computing emissions for airport sources of air pollution. In other cases, it is assumed that the users only have a general understanding of airports (and airport operations) and are comparatively less accomplished at conducting emissions inventories. In both instances, their understandings of SIPs and the General Conformity Rule are also expected to vary.

Other important variables that are expected to govern how this *Guidebook* is used involve the type and size of the airport(s) for which emissions inventories are prepared, the level of activity at the airport(s), the degree of accuracy and precision desired of the emissions inventory, and the availability of appropriate input data. Additional factors that must also be considered include some of the defining features of the SIP such as the pollutants-of-concern, the severity of nonattainment, and the types of emissions control measures required (see Chapter 3).

Reminder: Airport tenants, airlines, non-governmental organizations, consultants, and academia can also benefit from the information contained in the *Guidebook.*

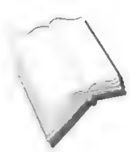
To serve this broad range of users and their needs, the *Guidebook* is designed around a common framework of concepts, tools, and

Table 1-1. Benefits to using the Guidebook.

Airport Operators	Air Quality Regulatory Agencies
Facilitation of SIP Process	
Assurance that airport improvement projects and actions are not in conflict with local air quality planning, and streamlining of the environmental review process required by law for these improvements.	Ensuring that airport contributions to the SIP emissions budgets are neither overstated nor underestimated, as well as ensuring that emissions control strategies based on these emissions budgets are the most effective in demonstrating attainment of the NAAQS by the U.S. EPA's required deadlines.
Accurate Representation	
The data and information in the SIP appropriately reflects the facility's emissions historically, currently, and in the future—ensuring that airport planning goals and future-year uncertainties are accounted for in the SIP at the time of environmental review.	An emissions inventory developed in concurrence with an airport allows for meaningful assessment relative to other airports and emissions sources in the SIP emissions budget and guides the development of air quality control strategies.
Cost and Time Saver	
Minimizes the costs of environmental compliance. Reduces project delays due to air quality concerns.	Minimizes the costs of environmental compliance. Reduces delays of the SIP implementation.
Transparency and Reproducibility	
The results and supporting data are recorded for retrieval and referral during environmental review of airport improvements.	Full disclosure of the data sources, assumptions, and methodologies, streamlining of the U.S. EPA's reviews of SIP adequacy and completeness.
Sound Methodology	
The methods used to assess airport data for the purposes of preparing emissions inventories are appropriate.	Airport-related emissions are computed using appropriate, consistent, and up-to-date methods, and the results are defensible.

techniques. For ease of use and understanding, the tools (i.e., approaches) are presented following a three-tiered approach, ranging from the most basic to the more complex. In this way, the information is beneficial to more users and has broader applications—regardless of skill levels and requirements.

The *Guidebook* also provides background information to aid the user with presenting the results and addressing other issues that commonly arise when preparing airport emissions inventories for SIPs. Resulting from this, the benefits to airport operators and air quality regulatory agencies from applying the methods and approaches described in the *Guidebook* are both abundant and tangible.



References: Guidebook users can learn about other ACRP publications pertaining to airports and air quality. These include the following:

- *ACRP Report 11: Guidebook on Preparing Airport Greenhouse Gas Emissions Inventories.*
- *ACRP Report 71: Guidance for Quantifying the Contribution of Airport Emissions to Local Air Quality.*
- *ACRP Report 78: Airport Ground Support Equipment (GSE) Emission Reduction Strategies, Inventory and Tutorial.*
- *ACRP Project 02-33,* "Guidance for Estimating Airport Construction Emissions."
- *ACRP Project 03-12,* "Guidebook for Preparing Peak-Period and Operational Profiles to Improve Airport Facility Planning and Environmental Analyses."

1.7 Contents of This Guidebook

The contents of the *Guidebook* are organized around five sections, or chapters, that build upon one another in a progressive fashion. However, for those that wish to focus on particular topics of interest, the *Topic Quick Lookup Guide* provides an index of the most commonly cited subject matter.

- **Chapter 1: Why Use This Guidebook?**—Provides a basic framework of information and experience that help to demonstrate the importance of having airport emissions properly accounted for in SIPs and describes how this *Guidebook* can be used to accomplish this goal.

Topic Quick Lookup Guide

Topic	Chapter/Appendix
Advanced Approach	3 & 4
Air Quality Regulations	2
Air Quality Standards	2
Aircraft	4
Airport Emission Sources	4
Airport Types	3
Approach Decision Tree	3
Attainment/Nonattainment	2
Auxiliary Power Units	4
Basic Approach	3 & 4
Case Studies	Appx. D
Clean Air Act	2
Conformity Determination	2
Coordination Best Practices	5
Data Sources	Appx. C
De Minimis Levels	2
Dispersion Modeling	5
Documentation & Reporting	4
EDMS	4
Emissions Estimator Tool	Appx. C
General Conformity Process	2
General Conformity Rule	2
Ground Support Equipment	4
Guidebook Benefits	1
Guidebook Objectives	1
Guidebook Stakeholders	1
Intermediate Approach	3 & 4
Inventory Approaches	3 & 4
Inventory Data Needs	3 & 4
Inventory Input Data	4
Inventory Time Periods	4
Pollutant(s)-of-Concern	4
QA/QC	4
SIP Research Findings	Appx. A
SIP Time Periods	4
SIPs	2 & 5
Transportation Conformity	2

- **Chapter 2: What are the SIP Requirements and the General Conformity Processes**—Provides summary explanations of what the *Guidebook* user needs to know about the NAAQS, including definitions for key concepts and terms associated with attainment, nonattainment, and maintenance areas; description of the purpose and function of SIPs; and an explanation of the roles of federal, state and local air quality agencies, as well as the CAA General Conformity Rule requirements—all with a particular emphasis on airports, wherever possible.
- **Chapter 3: How to Choose an Approach for Computing an Airport Emissions Inventory for an SIP**—Presents the user with several factors to consider when choosing an approach for preparing an airport emissions inventory. For the purposes of this *Guidebook,* there are three recommended approaches – each one designed for a range of airport types and operational levels coupled with varying degrees of accuracy, data needs, and resource requirements.
- **Chapter 4: How to Prepare an Airport Emissions Inventory for an SIP**—Describes the types of emissions sources found at airports and addressed in SIPs and the types of information and data considered necessary to develop an airport emissions inventory. These information and data are described in the context of the three individual approaches to preparing an airport emissions inventory (i.e., Basic, Intermediate, Advanced).
- **Chapter 5: SIP Coordination Strategies and Best Practices**—Describes the SIP development process from planning, through development, adoption, and to approval. This information serves as a guide to airport operators and air quality regulatory agencies for moving the results of the airport emissions inventory into the SIPs. Aligned with the SIP development process, specific recommendations are also provided that identify when coordination should be conducted and by whom, the objectives and end products of the coordination, and other best practices that airport operators and regulatory agency personnel can undertake to help ensure airport-related emissions are accurately, consistently, and appropriately accounted for in SIPs.

To aid in the comprehension of this material, a *Glossary* and lists of *References, Acronyms and Abbreviations* are provided at the end of the *Guidebook.* A compilation of *Frequently Asked Questions and Answers* is also provided to help the user answer questions that might arise in the course of reviewing and applying the information contained in this *Guidebook.* Finally, the following Appendices (available on the accompanying CD and online at www.trb.org, search for "Guidebook for Preparing Airport Emissions Inventories for State Implementation Plans") are intended to augment the materials presented within the *Guidebook* for users that require additional details, examples, and/or further explanations:

Key Point: Coordination between the two primary stakeholders (i.e., airport operators and air quality agencies) is "key" to ensuring that airport emissions are properly accounted for in SIPs.

- **Appendix A: Summary of SIP Review Research**—Contains a summary of the research findings on SIPs and how airport emissions have historically been incorporated.
- **Appendix B: Airport-Related Data Sources**—Contains an assembly of information, models, databases, and other supporting data and information that will enable the *Guidebook* user to implement the recommended approaches for preparing an airport emissions inventory.

- **Appendix C: Airport Emissions Estimator Tool**—Presents an easy method of developing an airport emissions inventory using the Basic Approach.
- **Appendix D: Case Studies**—Presents several case studies where airport emissions inventories have been successfully incorporated into existing SIPs.
- **Appendix E: Assessment of the "TAF+10" Formula**—Presents an assessment of this formula for compensating for the uncertainty in future-year airport operational forecasts.

Published separately, the *ACRP Project 02-21 Dissemination Plan* is designed to promote the distribution and use of the *Guidebook* for computing airport emissions inventories for SIPs. Also provided separately are the *ACRP Project 02-21 Presentation Materials* designed to help airport and air quality agency audiences understand how the *Guidebook* can be used by these stakeholders and other interested parties to help ensure that airport emissions are properly and accurately represented in SIPs.

Note: This *Guidebook,* the *Emission Estimator Tool, the ACRP Project 02-21 Dissemination Plan Presentations Materials,* and other supporting materials can be obtained electronically from www.trb.org, search for "Guidebook for Preparing Airport Emissions Inventories for State Implementation Plans").

CHAPTER 2

What Are the SIP Requirements and General Conformity Processes?

In alignment with the principal objectives of this *Guidebook* for ensuring that airport emissions are properly accounted for and conform to SIPs, this chapter provides essential information on (1) pertinent air quality regulations, (2) the purposes and types of SIPs, and (3) the requirements of the CAA General Conformity Rule—all with a particular emphasis on airports.

2.1 Air Quality Regulatory Overview

Reminder: Knowledge of the NAAQS, nonattainment areas, SIPs, and the General Conformity Rule are important to understanding and implementing the objectives of this *Guidebook*.

There is a wide array of federal, state, and local regulations governing air quality throughout the U.S. However, the federal CAA is principal among these regulations as it establishes the NAAQS for protecting air quality and promulgates the compliance requirements for when these standards are not met. How these elements of the CAA pertain to the objectives of this *Guidebook* is important and, therefore, discussed within the following sections.

2.1.1 Federal Clean Air Act

Title I of the CAA grants the U.S. EPA the authority to protect human health and welfare from the effects of air pollution nationwide. Several specific provisions of the Act serve to achieve this aim. For example, under Section 109 (National Primary and Secondary Ambient Air Quality Standards), the CAA requires the U.S. EPA to establish the NAAQS. However, while the U.S. EPA is authorized to set NAAQS, the states are responsible for achieving and maintaining the standards under Section 107 (Air Quality Control Regions).

In areas that do not meet the NAAQS (i.e., nonattainment or maintenance areas), the individual states need to develop and adopt plans, known as SIPs under Section 110 (State Implementation Plans for National Primary and Secondary Ambient Air Quality Standards). Finally, Section 176 (Limitation on Certain Federal Assistance), also known as the Conformity Rule, ensures that actions taken by federal agencies in nonattainment and maintenance areas do not interfere with the state strategies for meeting the NAAQS.

2.1.2 National Ambient Air Quality Standards

The NAAQS apply to seven air pollutants that are referred to as the U.S. EPA Criteria Air Pollutants (also referred to in this *Guidebook* as pollutant(s)-of-concern). The standards are designed to protect both the public health, known as Primary Standards, and public welfare (or the natural environment), known as Secondary Standards. Presently, these standards apply

Table 2-1. National Ambient Air Quality Standards.

Pollutants	Averaging Time	Concentration	Condition of Violation
Ozone (O_3)	8-hour	0.075 ppm	3-year average of the fourth-highest maximum 8-hour average.
Carbon Monoxide (CO)	8-hour 1-hour	9.0 ppm 35 ppm	No more than once per year.
Nitrogen Dioxide (NO_2)	Annual Average 1-hour	0.053 ppm 0.100 ppm	3-year average of the 98th percentile of the daily maximum 1-hour average.
Sulfur Dioxide (SO_2)	3-hour 1-hour	5 ppm 0.075 ppm	3-hour standard: No more than once per year 1-hour standard: Three-year average of the 98th percentile
Particulate Matter (PM_{10})	24-hour	150 μg/m^3	3-year average of the 98th percentile.
Particulate Matter ($PM_{2.5}$)	Annual Arithmetic Mean 24-hour	15 μg/m^3 35 μg/m^3	3-year average of the 98th percentile.
Lead (Pb)	Calendar Quarter	0.15 μg/m^3	Rolling 3-month average not to be exceeded.

Note: ppm = parts per million, μg/m^3 = micrograms per cubic meter.
Source: U.S. EPA, 2012, http://www.epa.gov/air/criteria.html.

to ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter (PM) equal to or less than 10 micrometers (coarse particulates or PM_{10}), PM equal to or less than 2.5 micrometers (fine particulates or $PM_{2.5}$), and lead (Pb).

As shown in Table 2-1, the NAAQS vary by pollutant based on three components: (1) an averaging time, (2) a maximum concentration, and (3) a condition of violation. For example, the 8-hour NAAQS for CO is 9 parts per million (ppm) which is not to be exceeded more than once per year. In addition to NAAQS, some states have also enacted more stringent standards and/or promulgated standards for other pollutants of local concern.

2.1.3 Attainment, Nonattainment, and Maintenance Areas

The U.S. EPA, state, and local air quality agencies maintain outdoor air monitoring networks to measure air quality conditions and gauge compliance with the NAAQS. Based upon the data collected by these agencies, all areas throughout the country are designated by the U.S. EPA with respect to their compliance with the NAAQS. The adjoining definitions summarize what these designations signify.

For O_3, CO, PM_{10}, and $PM_{2.5}$, the nonattainment designations are further classified by the severity, or degree, of the violation of the NAAQS. For example, in the case of O_3, these classifications range from highest to lowest as extreme, severe, serious, marginal, and moderate.

Importantly, the nonattainment designation of an area has a bearing on the emissions control measures required and the time periods allotted by

Attainment/Nonattainment Designations

Attainment

Any area that meets the NAAQS established for all of the criteria air pollutants.

Attainment/Maintenance

Any area that is in transition from formerly being a nonattainment area to an attainment area (also called Maintenance).

Nonattainment Area

Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) one or more of the NAAQS.

Unclassifiable

Any area that cannot be classified on the basis of available information as meeting or not meeting the NAAQS.

which an SIP must demonstrate attainment of the NAAQS. It is also important to note that the degree of nonattainment determines the thresholds of emissions that are considered to be "*de minimis,*" or levels below (i.e., within) which a formal General Conformity Determination is not required.

Finally, the boundaries of nonattainment areas are generally determined based on core based statistical areas (CBSAs) as defined by U.S. census data (air monitoring station locations and contributing emissions sources also play a role). However, nonattainment areas for localized pollutants such as lead and CO typically only constitute a partial CBSA or a local "hot-spot." By comparison, regional pollutants such as O_3 can encompass multiple CBSAs and can extend across state lines.

Note: Nonattainment areas are characterized by the following conditions and parameters:

- Designated by the U.S. EPA.
- Based on ambient monitoring data.
- Signify past or current violations of the NAAQS.
- Classified by severity of violation of the NAAQS.
- Boundaries may differ by pollutant.

2.2 State Implementation Plans

For the purposes of this summary explanation of SIPs, it is sufficient to characterize SIPs as the principal instrument by which a state formulates and implements its strategies for bringing nonattainment or maintenance areas into compliance with the NAAQS. In equally broad terms, the SIP contains the necessary emissions limitations, control measures, and timetables for achieving this objective. Therefore, the SIP development process is delegated to state air quality agencies that may in turn rely on regional, county, and local agencies to help prepare emissions inventories that include airport-related emissions.

Reminder: By necessity, SIPs are often voluminous and contain vast amounts of technical materials. Important information and data regarding airport-related emissions are usually contained in the Appendices.

2.2.1 Types and Purpose

Depending on the nonattainment/maintenance area designation, the types and purposes of SIPs vary. Such variations are based upon the stage and severity of the designation as well as the state of progress toward regaining attainment status. The SIPs that are the most pertinent to the aims of this *Guidebook* are listed in Table 2-2.

Based on the research conducted for this *Guidebook,* the majority of SIPs are Maintenance Plans (~60%), followed by Attainment Demonstrations (35%), Rate of Further Progress Plans (5%), and Early Action Compact Plans (3%). Information contained in Appendix A (available on accompanying CD and online at www.trb.org, search for "Guidebook for Preparing Airport Emissions Inventories for State Implementation Plans") also reveals how airport-related emissions have been incorporated into these SIPs.

2.2.2 SIP Components and Milestones

Among the various components that typically constitute an SIP, three of them are particularly relevant to the aims of this *Guidebook:* (1) the Base-Year Emissions Inventory, (2) the Future-Year Emissions Inventory, and (3) the Emission Reduction and Control Programs. Briefly described below in Table 2-3, each of these components have elements that are potentially significant to how airport-related emissions are viewed by federal, state, and local agencies that are involved in preparing and managing the SIP.

Table 2-2. Types of State Implementation Plans (SIPs).

Type	Purpose
Control Strategy SIPs	Control Strategy SIPs assess and stipulate the types and amounts of emission reductions and the control measures considered necessary to bring an area into compliance with the NAAQS within time periods dictated by the CAA. There are two types of Control Strategy SIPs, as follows: ▪ *Attainment Demonstration SIP*—This type of SIP includes existing and future-year areawide emission sinventories (and atmospheric dispersion modeling) that reflect the outcomes of various emission reduction strategies on future-year air quality conditions. ▪ *Rate of Further Progress (RFP) SIP*—A RFP SIP provides milestones to the Attainment Demonstration SIP, signifying that the incremental reductions in emissions are attained within prescribed timeframes thus ensuring that the area gains attainment by the applicable CAA deadline.
Maintenance Plans	These represent the majority of SIPs and contain revisions that demonstrate how a former nonattainment area will uphold the attainment status for a 10-year period following redesignation. A Maintenance Plan Update is also required for a second 10-year period following redesignation (i.e., an area's Attainment-Maintenance status applies for a total of 20 years). Maintenance Plans also identify the emissions control measures that would be implemented if an area exceeds the NAAQS after it is redesignated to attainment.
Early Action Compact Plans	In accordance with the CAA, 33 states with O_3 nonattainment areas submitted Compact Agreements to the U.S. EPA that demonstrated how they would meet the NAAQS earlier than required. The U.S. EPA deferred a designation of nonattainment for 14 of the areas and stipulated area-specific emission reduction milestones that must be met to maintain the attainment designation.
Conformity SIPs	These SIPs contain the state's procedures for interagency consultation during the nonattainment/maintenance periods and stipulate the conformity provisions should attainment not be achieved within prescribed timeframes.

Table 2-3. SIP components with potential airport significance.

SIP Components	Description	Airport Significance
Base-Year Emissions Inventory	Represents conditions that existed when the violations of the NAAQS first occurred, thus resulting in an area being designated nonattainment.	Divided into stationary, area, and mobile sources of emissions, airport-related sources of emissions (e.g., aircraft, APUs, GSE) typically occur in the mobile source category.
Future-Year Emissions Inventory	Represents forecasted emissions totals in the nonattainment or maintenance area based on expected changes in population and economic conditions coupled with emission reduction strategies contained in the SIP.	Airport-related emissions are expected to fit into the areawide emissions budget along with all other sources of emissions—including those associated with new airport improvement projects or actions. The uncertainties associated with future-year operational forecasts create significant challenges.
Emission Reduction and Control Programs	Composed of mandatory programs required under the CAA as well as initiatives administered under state and local regulations that are deemed necessary to meet the objectives of the SIP within the prescribed timeframes.	Airport-related sources of emissions could be subject to some emission reduction measures or programs.

Table 2-4. SIP milestones with potential airport significance.

SIP Milestones	Description	Airport Significance
NAAQS Review Cycle	U.S. EPA reviews and, if necessary, revises the NAAQS every 5 years, potentially resulting in new or redesignated nonattainment areas.	Indirectly applicable to airports by the designation of new nonattainment areas (see Nonattainment Designations, below).
Nonattainment Designations	States have 1 year to propose, and the U.S. EPA has 2 years to designate nonattainment areas, after new or revised NAAQS are adopted or when new violations of the NAAQS occur.	Newly designated nonattainment areas may include one or more airports.
SIP Development Phase	States must develop the SIP within 3 years after an area is designated as nonattainment.	Airport-related emissions should be identified and accounted for in the SIP.
Attainment Demonstration Period	SIPs must demonstrate compliance with the NAAQS within 5 years of being designated as nonattainment. Exceptions are set for specific pollutants based upon the area's nonattainment classification.	Under the CAA General Conformity Rule, emissions associated with airport improvement projects or actions must be shown to conform to the SIP.
SIP Revisions	Also termed "SIP Calls," the state must revise the SIP within 18 months following a finding of inadequacy by the U.S. EPA or if it fails to attain the standard. When a new standard, a revised standard, or a change in air quality conditions occurs, the U.S. EPA can issue an SIP Call requiring affected areas to revise the SIP.	Airport-related emissions should be identified and accounted for in the revised SIP.
Maintenance Period	Once a former nonattainment area has attained the NAAQS, it retains a maintenance status for 20 years. A Maintenance Plan is developed by the state demonstrating how this status will be achieved.	Airport-related emissions should be identified and accounted for in the Maintenance Plan.
Federal Implementation Plan (FIP)	If the U.S. EPA finds that a state failed to submit an adequate SIP, it must promulgate an FIP for the area within 2 years.	Airport-related emissions should be identified and accounted for in the FIP.

In addition to the three components listed above in Table 2-3, there are a number of milestones and timeframes inherent to SIPs that also have potential significance to airport emissions. Listed sequentially above in Table 2-4, these milestones and timeframes determine when airports may be targeted for SIP-related participation.

Among these milestone and time periods, the SIP Development Phase is the most relevant to the objectives of this *Guidebook* as this is the best opportunity for air quality agencies and airports alike to ensure that airport-related emissions are accounted for in an SIP.

Reminder: The SIP Development Phase is the most relevant to the objectives of this Guidebook as this is the best opportunity for air quality agencies and airports to ensure that airport-related emissions are accounted for in the SIP.

2.3 General Conformity Rule

As a means of ensuring that federal agencies uphold the objectives of the CAA, help maintain the NAAQS and, where applicable, remain compliant with SIPs, the U.S. EPA promulgated the conformity pro-

visions of the federal CAA. Under the conformity regulations, federal agencies are prohibited from funding, permitting, or supporting in any way actions or projects that interfere with an approved SIP or the state's ability to attain and maintain the NAAQS. To address these requirements, the CAA contains two sets of conformity regulations: (1) Transportation Conformity and (2) General Conformity, as shown in Table 2-5.

Table 2-5. Conformity regulations.

Transportation Conformity	General Conformity
Applies to highway and transit projects and actions (e.g., highways, roadways, rail, bridges).	Applies to all other actions in which federal agencies are involved (e.g., airports, military bases, federal buildings).

Many airport-related actions and developments constitute federal actions involving the FAA and thus fall under the General Conformity Rule. Examples include (but are not limited to) airport layout plan (ALP) updates; new airports, runways, or taxiways; new or expanded air carrier service; and new ground-based airfield procedures. Exceptions include airport safety projects, maintenance activities, and project or actions included on the FAA's Presumed-to-Conform List (i.e., activities demonstrated to have only minor emissions).

For clarity and ease of understanding, the purpose and tenants of the General Conformity Rule as it applies to airport projects and actions involving the FAA are stated below.

By comparison, the Transportation Conformity Rule is usually associated with highway and transit projects and seldom applies to airport projects. Exceptions potentially include highway interchanges or rail projects located on airport property.

2.3.1 Applicability and General Conformity Process

In its most basic form, the General Conformity Process can be subdivided into two primary components: (1) the Applicability Analysis, and (2) the Conformity Determination. Discussed separately below, each component has some important terms and concepts that would be helpful to *Guidebook* users to understand.

Reminder: The General Conformity Rule of the federal CAA is separate from, but is often addressed, during the Environmental Impact Statement/ Environmental Assessment (EIS/EA) process for airport projects.

Applicability Analysis—As a means of first determining if the General Conformity Rule applies, the following four key criteria, or benchmarks, should be considered:

- **Federal Agency Involvement**—The General Conformity Rule pertains to actions and projects that involve federal agencies. Therefore, if there is no involvement (i.e., funding or decision making) by a federal agency, such as the FAA, the rule does not apply. FAA actions range from (but are not limited to) airport funding programs, ALP approvals reflecting a wide assortment of airport improvement projects and actions.
- **Attainment Status**—Since the General Conformity Rule is intended to ensure that federal actions will not interfere with the SIP or the state's ability to attain and maintain the NAAQS, the rule only applies to federal actions planned in designated nonattainment or maintenance areas.

General Conformity Rule

Federal agencies (e.g., the FAA) are prohibited from funding, permitting, or supporting in any way aviation-related activities that interfere with an approved SIP or the state's ability to attain and maintain the NAAQS. The overriding purpose is to ensure that airport projects or actions:

- Do not cause or contribute to new violation of NAAQS;
- Do not cause additional or worsen existing violations of the NAAQS; and
- Do delay attainment of the NAAQS.

General Conformity Rule De Minimis Levels	
Pollutant	***De Minimis* Levels (tpy)**
VOCs	10 to 100
NO_x	10 to 100
CO	100
SO_x	100
$PM_{10/2.5}$	100

- ***De minimis* Thresholds**—The General Conformity Rule acknowledges that many federal projects and actions will predictably have little or no effects on air quality in nonattainment or maintenance areas. Therefore, based on the pollutant(s)-of-concern and the degree of non-attainment, thresholds have been set below which actions are considered to be *de minimis* and, therefore, do not apply.
- **Presumed-to-Conform**—The General Conformity Rule also allows for federal agencies to identify projects and actions that either do not increase emissions or result in emissions proven to be below the *de minimis* thresholds under all circumstances. The FAA was among the first federal agency to adopt a Presumed-to-Conform list of actions. These include (but are not limited to) airport safety and security projects; airport navaids, signage, and lighting systems; terminal upgrades; and alternative fuel vehicle programs.

Based on these criteria, the requirements of the General Conformity Rule only apply to airport-related projects or actions when (1) there is a federal (i.e., FAA) action, (2) the area in which the project occurs is designated nonattainment or maintenance, (3) the project-related emissions are above the *de minimis* thresholds, and (4) the proposal is not among the FAA's Presumed-to-Conform projects or actions.

Conformity Determination—For those cases where the General Conformity Rule does apply, it must then be further demonstrated that the emissions associated with the project or action will conform to the goals and objectives of the SIP. For the purposes of this *Guidebook*, there are four distinct approaches to meeting this requirement, explained below. For ease of following the discussion, Figure 2-1 also illustrates the alternative pathways (designated as *Alts. 1 through 4*) to making a conformity determination.

- **Demonstrate Project/Action Emissions are *De minimis* (*Alt. 1: a.k.a., the Applicability Test*)**—As discussed above, based on the pollutant(s)-of-concern and the degree of non-attainment, thresholds have been set below which emissions totals are considered to be *de minimis* and, therefore, are automatically assumed to conform to the SIP. Under this approach, project- or action-related emissions associated with airport improvements are first computed as an emissions inventory and compared to the applicable *de minimis* levels. If these emissions are below (i.e., within) the thresholds, they meet this criteria.
- **Include the Emissions in the SIP (*Alt. 2*)**—Under this approach, the emissions associated with the airport projects or actions are accounted for in an SIP. This can be confirmed by direct comparison to SIP emissions inventories, showing that the emissions are specifically

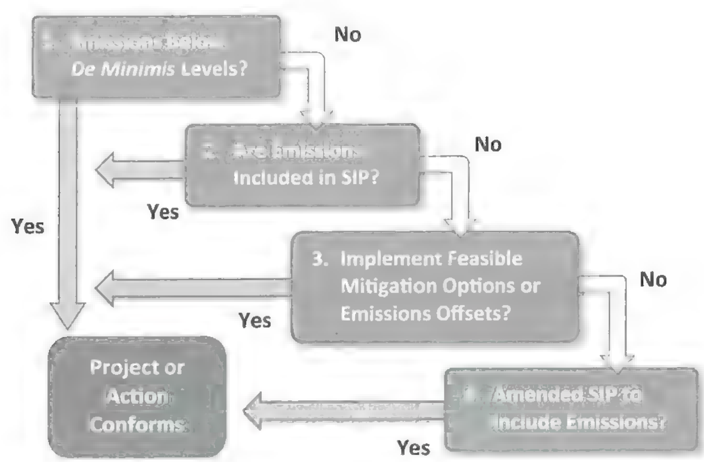


Figure 2-1. General conformity pathways.

identified or implicitly included in the airport emissions categories. Alternatively, a determination from the state/local air quality regulatory agency stating that the project emissions (together with all other area-wide emissions) would not exceed the overall emissions budget in an SIP would suffice. In this way, it is assured that even with these airport-related emissions, the goals and objectives of an SIP will remain intact. It is noteworthy that this approach is a significant incentive to airport operators to participate in the SIP development process.
- **Mitigate or Offset Emissions** (*Alt. 3*)—Under this approach, the emissions associated with the projects or actions are reduced to levels that conform to an SIP. In some cases, this is accomplished by implementing sufficient emission reduction measures along with the project. In other cases, equivalent amounts of emissions are reduced elsewhere as a means of offsetting the project-related emissions. In both cases, the reduction measures and offsets must be real, permanent, quantifiable, surplus to existing emission reduction strategies in the area, and verifiable. Importantly, to meet this General Conformity requirement under this approach, the full offset of the project-related emissions is required.
- **Amend the SIP** (*Alt. 4*)—Under this approach, an SIP is updated to include the emissions associated with the proposed project and action. Because this option requires a written commitment from the governor to revise an SIP and may require reassessing emissions limitations area-wide, it is viewed as the least desirable of the methods.

Supplementary to each of these approaches are documentation and reporting requirements that must be fulfilled to complete the General Conformity Determination process. For example, there are *Draft* and *Final Conformity Determination Reports*, agency distribution and review requirements, mandatory public notices of 30-day comment periods, as well as opportunities for public hearings (see Figure 2-2).

There is one additional approach of demonstrating conformity with an SIP. Referred to as a Facility Wide Emissions Budget, this emissions estimate identifies specific quantities of pollutants and pollutant precursors that can be emitted on an annual or seasonal basis and identifies measures that are/will be taken to ensure compliance with the budget. The inventories prepared using the approaches in this *Guidebook* could be used to prepare the aircraft, APU, and GSE estimates for such a budget.

Figure 2-2. Formal general conformity process.

2.3.2 Applicability to Airports

For the purposes of this discussion, the General Conformity Rule applies to airport-related emissions whenever a federal agency (i.e., FAA) approval is required and the airport is located in an area that is designated nonattainment or maintenance for one or more of the criteria pollutants. However, in some cases actions by other federal agencies may also require compliance with the General Conformity Rule. An example would be the issuance of a Clean Water Act Section 404 permit by the U.S. Army Corps of Engineers.

2.3.3 Roles and Responsibilities

As the lead federal agency involved in most airport-related development plans, the FAA is ultimately responsible for demonstrating that an action or project will not interfere with the SIP and meet the requirements of the General Conformity Rule. Therefore, the FAA prepares or oversees the conformity documentation processes. If a formal conformity determination is required, the U.S. EPA, state, and local governmental agencies can also be involved during the review and comment periods.

Reminder: The FAA is the federal agency that must meet the requirements of the CAA General Conformity Rule for airport-related projects.

Airport operators also play an important role in the conformity process as they are usually the original proponent of the project or action. In some cases, the airlines and other airport tenants also have a role depending on their involvement with the proposed project or action.

2.4 Transportation Conformity

As briefly noted, the Transportation Conformity Rule applies mainly to highway and transit projects and actions. Examples include new and expanded roads and highways, mass transit systems, and railway facilities. Correspondingly, the federal agencies most often involved include the Federal Highway and Transit Administrations (FHWA/FTA). Because of this distinction, the Transportation Conformity Rule applies less frequently to airport-related projects and actions. The exceptions being in those instances where the proposed roadway, transit, or railway facilities occur on airport property or actions to improve access to/from an airport are needed on the regional surface transportation system.

Reminder: Airport-related projects or actions are typically not subject to the requirements of the Transportation Conformity Rule.

Typically, if an airport improvement project has the potential for an air quality impact upon a regionally significant roadway (a roadway reflected in the regional modeling), the state transportation agency or metropolitan planning organization need to certify that these air quality impacts are accounted for in their Transportation Conformity assessment developed in conjunction with the state air agency, hence demonstrating conformance to the SIP.

CHAPTER 3

How to Choose an Approach for Computing an Airport Emissions Inventory for an SIP

As discussed in Chapter 1, the primary aim of this *Guidebook* is to provide guidance in preparing airport emissions inventories of the U.S. EPA criteria pollutants (and their precursors) for inclusion in SIPs. Focusing on the needs of the two principle stakeholders of this ACRP initiative, (1) airport operators and (2) air quality regulatory agencies, this chapter is designed to help these *Guidebook* users formulate and select an appropriate approach to preparing the inventory. Chapter 4 provides recommendations and resources for conducting the analysis and presenting the results based on the selected approach.

3.1 Alternative Approaches

For *Guidebook* user convenience and to account for the range of factors that ought to be considered when preparing airport emissions inventories for SIPs, this *Guidebook* describes three alternative approaches. Notably, each approach contains a common set of features that are viewed as central to preparing an emissions inventory but are otherwise distinct from one another. Arranged in increasing order of relative complexity (i.e., from the simplest to the most advanced), the three approaches (Basic, Intermediate, Advanced) are briefly described below in terms of their most prominent characteristics.

3.1.1 Basic Approach

The Basic Approach is the simplest approach and provides a conservatively high estimate of an airport's emissions inventory. While the Basic Approach relies on the same basic aircraft operations data as the Intermediate and Advanced Approaches, the aircraft fleet mix data are generalized and conservative assumptions regarding aircraft engine assignments are utilized. The Basic Approach also relies on EDMS default assumptions regarding aircraft taxi/delay times, APU use times, and GSE fleet mix and use times. Requiring the least amount of input data the Basic Approach is best suited for non-hub commercial and general aviation (GA) airports with typical airfield operating characteristics and less than 100,000 annual operations. To facilitate the preparation of an airport emissions inventory using the Basic Approach, an *Airport Emissions Estimator Tool* has been developed as a companion to this *Guidebook* (see Appendix C, available on the accompanying CD and online at www.trb.org, search for "Guidebook for Preparing Airport Emissions Inventories for State Implementation Plans").

Basic Approach

- Requires least amount of airport-specific data.
- Creates conservatively high emissions estimates.
- Suitable for GA and non-hub airports with <100,000 operations.
- Paired with the *Airport Emissions Estimator Tool (See Appendix C).*

3.1.2 Intermediate Approach

The Intermediate Approach is viewed as transitional between the Basic and Advanced approaches by producing results with a higher level of accuracy than the former while

Intermediate Approach

- Data needs are in between the Basic and Advanced approaches.
- Accounts for airport-specific operating characteristics.
- Uses EDMS default data for aircraft engines, APU, GSE.
- Applicable to large GA and small-to-medium-hub airports.

requiring less input data than the latter. Based on airport-specific operations, aircraft fleet mix and airfield operational data, this approach also relies on default databases within EDMS for aircraft engine, APU, and GSE emissions characteristics. The Intermediate Approach is generally considered suitable for large GA and small-to-medium-hub commercial airports located in moderate nonattainment and maintenance areas.

3.1.3 Advanced Approach

Using the EDMS, the Advanced Approach produces an emissions inventory with the highest level of airport specificity and is therefore considered to be the most accurate. Rather than relying on default input parameters, this approach requires the greatest levels of expertise and effort by the preparer and is the most data intensive. This approach is best suited for large-hub commercial airports but can also be applied to small-to-medium-hub and GA airports where advanced levels of accuracy and airport specificity are desired. This approach is also most appropriate for airports located in nonattainment areas with serious-to-extreme severity designations (see Chapter 2).

Advanced Approach

- Requires greatest amount of input data.
- Produces highest level of emissions inventory accuracy.
- Uses the EDMS with airport-specific operational, meteorological, APU, and GSE data.
- Recommended for large hub airports and when greater specificity and accuracy are desired in the results.

3.2 Factors to Consider When Choosing an Approach

To aid the preparers of airport emissions inventories in evaluating and choosing an approach, this section focuses on several of the most important factors, or issues, that will likely be encountered, weighed, and decided upon by the users of this *Guidebook*. For ease of reference, Figure 3-1 provides a matrix that couples these considerations with the corresponding Basic, Intermediate, and Advanced approaches.

3.2.1 Expertise of the Preparer

The most appropriate approach to conducting an airport emissions inventory will depend in part on the expertise of the preparer. In some cases, it is expected that the preparer will possess a high level of knowledge and experience related to computing emissions for airport sources (e.g., aircraft, GSE, APUs). In other cases, it is assumed that

Approach/Factors	Basic	Intermediate	Advanced
Preparer Expertise	Low	Medium	High
Nonattainment Status	Marginal-to-Moderate	Moderate-to-Serious	Serious-to-Extreme
Airport Type	Non-Hub & GA	Small-to-Medium Hub	Medium-to-Large Hub
Data Needs & Availability	Least	Moderate	Detailed
Accuracy	Course	Refined	Precise
Time & Cost	Least	Moderate	Most

Figure 3-1. Airport emissions inventory approach factors.

the users may only have a general understanding of airports (and airport operations) and be comparatively less accomplished conducting an emissions inventory. In both instances, the levels of understandings of SIPs and the General Conformity Rule are also expected to vary.

In recognition of these variances in skill and knowledge associated with airports and air quality in general, and with preparing airport emissions inventories in particular, three levels of expertise are expected among the users of this *Guidebook:* high, medium, and low as displayed in Figure 3-2.

Importantly, this three-level characterization should not be misconstrued to mean that those with low levels of expertise only use the Basic Approach, those with mid-level expertise only use the Intermediate Approach, and those with high-level expertise only use the Advanced Approach. Rather it is intended to serve as a signal to the preparer of the airport emissions inventory that their expertise should correspond as closely as possible to the level of the analysis, particularly in those cases that are data intensive and a high level of accuracy is required.

High Level

These preparers are well acquainted with airport operations and possess working knowledge of airport operational databases, EDMS, as well as expertise in processing data for aircraft engines, APUs, and GSE.

Medium Level

These preparers have some prior experience using EDMS and possess the ability to interpret and apply airport operational databases and emissions inventories.

Low Level

These preparers are infrequent or "first-time" users of EDMS and are unfamiliar with the use and interpretation of airport operational databases and emissions inventories.

Figure 3-2. Guidebook user expertise.

3.2.2 Nonattainment Area Designation

According to their intended purpose, SIPs are prepared to help guide areas with unacceptable air quality into compliance with the NAAQS. Therefore, because it is expected that airport emissions inventories prepared following this *Guidebook* are for airports located in designated nonattainment/maintenance areas—the area's classification and degree of nonattainment are important considerations when selecting an approach.

With respect to these designations, it is simply the presence of an airport within a nonattainment (or maintenance) area that warrants the preparation of an airport emissions inventory for inclusion in a SIP. In other words, airport-related emissions inventories should be included in all SIPs—except in those cases where there are no airports located in the nonattainment/maintenance areas.

Note: Nonattainment and Maintenance Areas are listed in the U.S. EPA *Green Book of Nonattainment Areas* by pollutant, state and county (but not by airport) http://www.epa.gov/airquality/greenbook/.

Importantly, O_3 and PM_{10} nonattainment areas are further differentiated by the degree of noncompliance with the NAAQS—ranging from marginal to extreme. For these areas, the SIP's emission reduction requirements, control measures, and compliance timetables are shaped by this severity indicator. In other words, emissions inventories and control measures are incrementally more rigorous in SIPs prepared for nonattainment areas with more severe nonattainment designations compared to those with lower classifications. As a result, preparers of emissions inventories for airports located within severe and extreme O_3 nonattainment areas (or serious PM_{10} nonattainment areas) should consider using the approaches that produce the most accurate results.

3.2.3 Airport Type, Function, and Activity Level

When preparing airport emissions inventories for SIPs, it is important to recognize that there are different types of airports and that the availability of existing and future aircraft activity levels at these airport facilities can vary significantly.

For example, of the nearly 20,000 airway facilities presently in the U.S., approximately 5,000 (or 25 percent) are public-use airports while the remaining 75 percent are privately owned and not for general use. Of the 5,000 public-use airports, about 3,000 are included in the FAA's National Plan of Integrated Airport Systems (NPIAS), the Terminal Area Forecasts (TAF) and/

Airport Categories

Commercial

Primarily designed and operated to serve passenger- and cargo-carrying aircraft, these airports are the center of aviation activity in most metropolitan areas. Some commercial airports are origin/destination airports for in- and out-bound aircraft while others also function as transfer points (i.e., "hubs") for passengers and cargo traveling to their ultimate destinations.

Reliever

These airports are designated to relieve operational congestion and delays at commercial service airports and to provide improved GA access to the overall communities in which they are located. In general, reliever airports are among the busier GA airports with higher percentages of business jet operations.

General Aviation

These airports are typically smaller (i.e., have less activity) than commercial airports and primarily serve privately owned and operated, non-commercial, aircraft. These airports often have a greater proportion of single- and multi-engine propeller or turboprop aircraft and typically less turbine-powered aircraft than their commercial counterparts.

Figure 3-3. Airport categories.

or the Air Traffic Activity Data System (ATADS)—thus making their activity levels relatively current and accessible.

Public-use airports are also characterized by their primary function(s), which are broadly classified as commercial, reliever, and GA—with many airports serving more than one role. These three types of airports are described in Figure 3-3.

Finally, commercial and reliever airports are further categorized by their activity levels (based upon the number of annual aircraft operations and/or passengers), as follows:

- **Large Hub**—Located mainly in major metropolitan areas, large-hub airports can accommodate aircraft of all sizes and serve as the principal gateways for both domestic and international air travel. These airports accommodate at least one percent of nationwide enplanements (i.e., passengers) and include the Hartsfield-Jackson Atlanta, Los Angeles, and Salt Lake City International Airports.
- **Medium Hub**—These airports serve the same function and types of aircraft as large hubs, but represent between 0.25 percent and less than 1 percent of the enplanements nationwide. Examples include Cincinnati, Sacramento, and Tucson International Airports.
- **Small Hub**—These airports typically serve smaller commercial service markets and represent less than 0.25 percent of nationwide enplanements. Examples include Manchester-Boston Regional, Boise, and Fresno International Airports.
- **Non-Hub**—These commercial service airports accommodate less than 0.05 percent of the nationwide enplanements. Examples include Key West and Idaho Falls Airports.

Because airport emissions are generally proportional to aircraft operations, preparers of emissions inventories for large- and medium-hub commercial airports should consider using the most advanced and accurate approaches (i.e., Intermediate and Advanced). By comparison, for emissions inventories of small- and non-hub commercial airports and GA airports, using less sophisticated approaches may be acceptable. Figure 3-4 provides a general illustration of these airport types and their examples.

3.2.4 Data Needs and Availability

Of all the factors and considerations given to preparing an airport emissions inventory for an SIP, the availability of input data and supporting information is one of the most meaningful and potentially limiting. Moreover, in most cases this information and input data reflect the individual design and operational features of the airport and thus govern the accuracy of emissions inventory results.

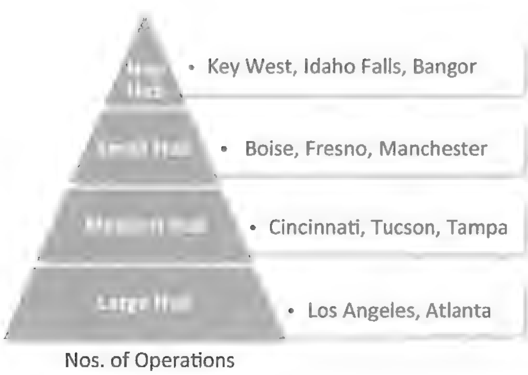


Figure 3-4. Airport types.

For example, aircraft operational data (e.g., annual operations, fleet mix, taxi times, etc.) can vary widely between airports of similar size and function based on airfield layout, local meteorological conditions and/or noise mitigation, and other operational programs. Likewise, among airports with comparable operational data, the aircraft fleet mix can also differ markedly according to the principal airlines serving the airport and the origination/destination markets. These aircraft operational levels, fleet mix, and operating parameters will also change over time due to technological advancements and/or varying market conditions. Fortunately, much of the operational data for commercial airports are typically available, up to date, and obtainable from the TAF and ATADS databases as well as airport-specific planning

documents. By comparison, these operational data for GA airports are often limited, difficult to obtain, or out of date.

To further demonstrate the significance of this consideration, Table 3-1 provides a partial listing of the data that are expected to be required when preparing an airport emissions inventory for SIPs using this *Guidebook*. As shown, these data mainly account for the airport's operational levels: the aircraft, APU, and GSE fleet characteristics as well as the local meteorological conditions.

Reminder: Input data are "key" to producing reliable airport emissions inventory results but are often limited in scope, difficult to obtain, or require development by the preparer.

It is also noteworthy that depending on the selected approach to preparing the airport emissions inventory, these input data needs will vary. For example, under the Basic Approach, only aircraft operational levels and fleet mix characteristics data are required to compute aircraft, GSE and APU emissions. By comparison, under the Advanced Approach, all of these data identified in Table 3-1 are pertinent and necessary.

3.2.5 Level of Accuracy

By general definition, the accuracy of an emissions inventory is a function of how close the estimated results are to actual values. However, because airports are composed of mobile sources (e.g., aircraft, APUs, and GSE) of emissions that are owned and operated by various entities and that the use of these sources are typically under the control of the airport operator, the actual (i.e., "real world") amounts of emissions generated are more difficult to quantify.

Key Point: Because of the uncertainties associated with future-year airport operational forecasts, the accuracy of airport emissions inventories are somewhat uncertain. Therefore, this *Guidebook* recommends the "TAF+10" Approach whenever necessary to help compensate for these uncertainties (see Section 4.6).

Therefore, it is the quality of the input data that best determines the level of accuracy of the airport emissions inventory. In other words,

Table 3-1. Airport emissions inventory data needs.

Data Needs	Description	Approach		
Aircraft		Basic	Inter.	Adv.
• Operations	Total number of LTOs (landings and take-offs) categorized by aircraft fleet mix.	✓	✓	✓
• Fleet Mix	Aircraft types by model (e.g., B777, A380, Cessna, etc.) or by category (i.e., air carrier, air taxi, GA, military).	✓	✓	✓
• Times-In-Mode	Average ground-based taxi time (i.e., taxi-in, taxi-out, and queue delay) in minutes.		✓	✓
• Engine Type	Most common model by aircraft type or by aircraft-specific assignments.			✓
Auxiliary Power Units (APUs)				
• Assignment	Presence and model by aircraft type.			✓
• Operating Time	Total operating time for taxi-in, taxi-out, and parked at gate, in minutes.			✓
Ground Support Equipment (GSE)				
• LTO-Based	GSE category (e.g., aircraft tractor, baggage tug, etc.) and fuel type (i.e., diesel, gasoline, etc.) by aircraft type.			✓
• Population-Based	Total airport-based units by GSE category, fuel type, and operating time, in minutes.			✓
Meteorology				
• Mixing Height	Height of atmospheric mixing zone, in feet or meters.		✓	✓
• Temperature	Average Annual Temperature as °F.		✓	✓

Basic = Basic Approach, Inter. = Intermediate Approach, Adv. = Advanced Approach

Figure 3-5. Levels of accuracy.

the use of airport-specific data that are up to date and sufficiently detailed is expected to produce results that are more accurate than an assessment that relies on a set of generalized or worst-case assumptions. Again, the critical data inputs to the emissions inventory such as aircraft operations, fleet mix, and taxi/delay times as well as APU/GSE data for historic, current, and/or future-year conditions are all important variables in this regard.

Consequently, the relative levels of accuracies among the three approaches outlined in this *Guidebook* are proportional to the descriptor level (i.e., Advanced > Intermediate > Basic) as shown in Figure 3-5.

3.2.6 Preparation Time and Costs

The preparation time and financial costs for preparing an airport emissions inventory for an SIP are determined in large degree by the approach selected to complete the work. Therefore it follows that under the Basic Approach where the input data needs are limited to the airport operational levels and a generalized aircraft fleet mix, the preparation time and costs are expected to be lower when compared to the Advanced Approach, which involves the use of EDMS and an array of input data.

Idea: Airport operators can aid in reducing preparation times and costs for conducting airport emissions inventories by collecting supporting data and information ahead of time.

Among the other factors and variables that can potentially affect the preparation time and costs for conducting the analyses is the availability of the required input data. In other words, the collection, development, and preparation of the input data for the emissions inventory require research and analyses that are additive to computing the results.

For example, airport-specific GSE fleet mix, fuel type, and operating time data are typically collected from the equipment owners or developed from field surveys. In other cases, the forecasting of airport operational levels, predicting aircraft fleet mix data, or foreseeing APU/GSE utilization under future-year conditions involves additional research and development time, also adding to the overall costs.

3.2.7 Other Factors

Finally, there are an assortment of conditions or circumstances that may deserve special consideration by *Guidebook* users when selecting an approach to preparing an airport emissions inventory for an SIP. The relevance of these factors could justify rejecting use of lower accuracy approaches (e.g., Basic) for higher accuracy approaches (e.g., Advanced). Some of these factors are listed in Table 3-2 along with brief explanations as to why they may be important.

Note: When computing airport emissions inventories, accurate and airport-specific results are preferred over generalized or conservatively high estimates of emissions. However, other modifying factors and considerations may impede this objective and cannot be ignored.

In these cases, it is recommended that the airport emissions inventory be prepared for the SIP following approaches that best accommodate these unique characteristics.

3.3 Selecting an Approach

Section 3.1 introduced the three recommended approaches to preparing an airport emissions inventory for an SIP and briefly dis-

Table 3-2. Special considerations when selecting an approach.

Factor	Why It Matters
Airport Operational Levels	
Changes in Airport Operational Levels and Conditions	Airports planning major near- or long-term improvements or significant changes in activity levels that are unaccounted for in current forecasts could over/underestimate emissions using lower accuracy approaches.
Airfield Operating Conditions	
Uncharacteristic Operating Conditions	Airports with operating conditions that deviate greatly from typical (or default) airfield taxi/delay times, seasonal changes, etc. could over/under-estimate emissions using lower accuracy approaches.
Aircraft Fleet Mix	
Unique Aircraft Fleet Mix Characteristics	Airports with unusual proportions of aircraft types such as cargo, military, or GA, and/or sizes (wide- or narrow body), etc. could over/under estimate emissions using lower accuracy approaches.
Meteorological Conditions	
Uncommon Meteorological Conditions	Airports located in areas where atmospheric mixing heights vary significantly from standard conditions (i.e., 3,000 feet) could over/under estimate emissions using lower accuracy approaches.
Nonattainment Designation	
Degree of Nonattainment	Airports located in nonattainment areas designated as extreme, severe, and serious could be required to use approaches with the highest accuracies.
Emission Reduction Measures	
Qualifying Emission Credits	Airports with emission reduction initiatives such as the FAA Voluntary Airport Low Emissions (VALE) program could obtain Airport Emission Reduction Credits (AERCs) by including them in the SIP using the Advanced Approach.

cussed their most prominent characteristics. Section 3.2 identified and discussed several of the most important factors, or issues, likely to be encountered, weighed, and decided upon by the preparers of airport emissions inventories. Based on this information, this section is intended to help *Guidebook* users choose the most appropriate approach for their airport(s) and/or SIPs. Chapter 4 provides guidance on preparing an airport emissions inventory based upon the selected approach.

3.3.1 Benefits Versus Costs

Ultimately, the process of formulating and selecting an approach for preparing an airport emissions inventory becomes a compromise, or balance, as shown in Figure 3-6, between the benefits of obtaining results that are as accurate and as airport-specific as possible, while considering the overall costs in terms of the input data, personnel, and time required to complete the work. In some cases, this benefit/costs decision is also a function of who is preparing the inventory and for what purpose.

Figure 3-6. Balancing benefits and costs of approach selection.

For example, preparers of an emissions inventory for large-hub commercial airports located in severe O_3 nonattainment areas are more incentivized and enabled to conduct a higher-level (i.e., more detailed) analysis commensurate with the need for accurate and defensible results. By comparison, preparers of emissions inventories for GA airports located in CO maintenance areas may possess less incentive and have fewer resources to conduct such detailed analyses. In other instances, air quality agency staff may have

multiple airports or an array of other non-airport emissions sources to quantify within a nonattainment area but limited resources and time to complete the work.

Therefore, finding the suitable balance and selecting the appropriate approach to preparing an airport emissions inventory for an SIP is typically achieved by evaluating the array of factors discussed above in Section 3.2 and weighing the benefits and costs of each one individually, then as a group. However, because there is no "one-approach-fits-all" solution for preparing airport emissions inventories, the decision is usually made on a case-by-case (i.e., airport-by-airport or SIP-by-SIP) basis.

3.3.2 Advantages and Disadvantages

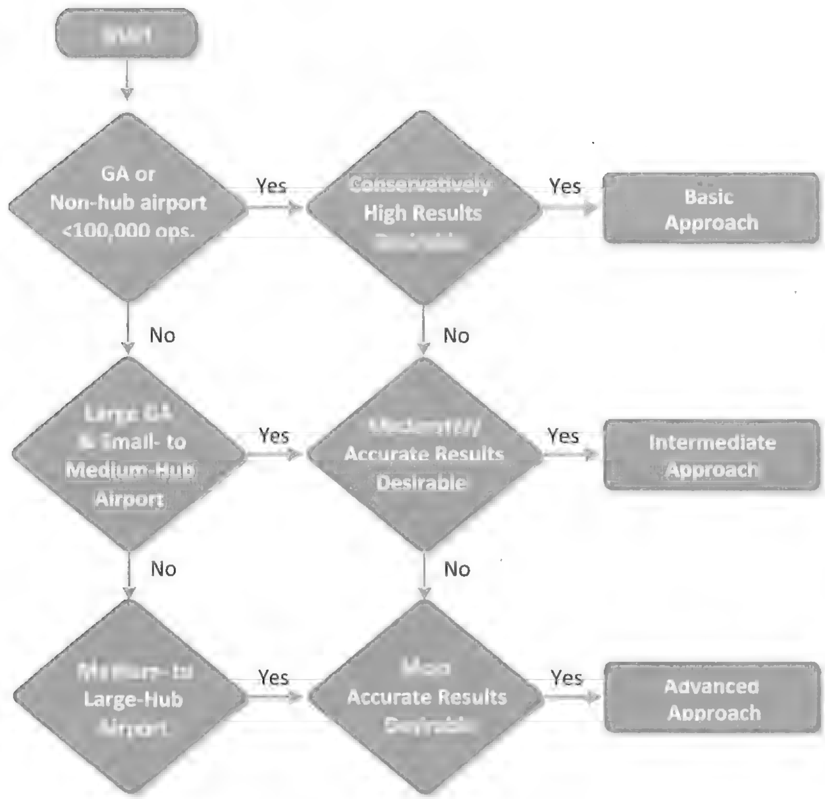
As discussed, each approach to preparing an airport emissions inventory contained within this *Guidebook* comprises a set of features that, when combined together, form a coherent and consistent framework that is distinct from the others. Initially identified and described above in Section 3.1, the three approaches also possess clear-cut benefits and shortcomings that may be considered when undertaking an airport emissions inventory.

For ease of comparison, Table 3.3 provides a summary listing of what are viewed as some of the most important advantages and disadvantages associated with the three individual approaches. It is anticipated that *Guidebook* users will benefit by evaluating these criteria during their own approach selection process.

As shown, each approach has an equal share of advantages (i.e., pluses) and disadvantages (i.e., negatives) in terms of its input data requirements, accuracy, and airport applicability. Notably, it is this variance among the three approaches that justifies the need for each one.

Table 3-3. Comparison of airport emissions inventory approaches advantages and disadvantages.

Advantages	Disadvantages
Basic Approach	
+ Ease of use	- Least accurate
+ Minimal data needs	- Produces conservatively high results
+ Least preparation time and costs	- Not recommended for medium- to large-hub airports
+ Suitable for non-hub and GA airports when input data is limited.	- Not recommended for serious-to-extreme nonattainment areas
Intermediate Approach	
+ More accurate than Basic Approach	- Not as accurate as Advanced Approach
+ Requires less data than Advanced Approach	- Uses EDMS default data for aircraft engines, APUs, GSE
+ Uses FAA's EDMS.	- Requires experience with EDMS
+ Suitable for small- to medium-hub airports and large GA airports	- Not recommended for large-hub airports
Advanced Approach	
+ Most accurate	- Requires the most input data
+ Highly airport specific	- Greatest preparation time and costs
+ Optimizes the features of EDMS	- Requires high-level expertise with EDMS
+ Suitable for medium- to large-hub airports	- Overly complex for small airports



Note: ops. = operations.

Figure 3-7. Airport emissions inventory approach selection decision-tree diagram.

3.3.3 Making a Selection

As discussed above in Section 3.2, there are a number of factors to consider when formulating an approach to preparing an airport emissions inventory, and in Section 3.3.2 the pros and cons of each approach are identified. This section serves as a final distillation of the approach decision-making process to aid *Guidebook* users in the selection process.

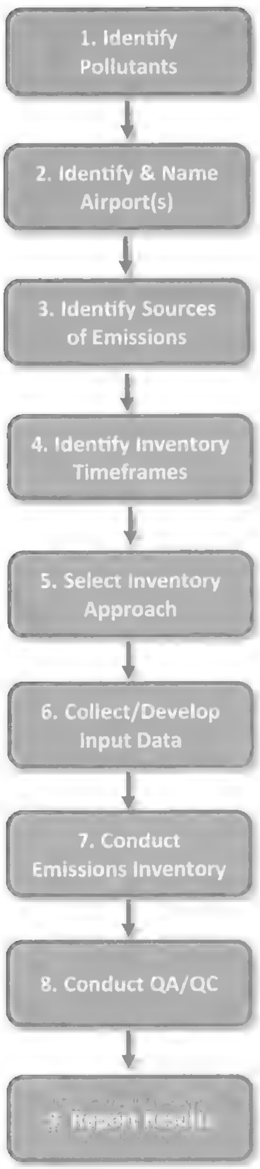
Using two important variables, Figure 3-7 presents a simple decision-tree diagram to further assist in the selection process. As shown, *Guidebook* users are first urged to take into account the airport size and function (e.g., small-, medium-, large-hub, or GA) and then the assessment's level of accuracy. Following this course, the scale of the airport's emissions are appropriately matched to the individual approach and the user is able to determine the desired accuracy of the emissions inventory results.

For example, preparers of emissions inventories for GA and non-hub airports are guided to utilizing the Basic Approach based on operational levels but can elect to use the Intermediate Approach for greater accuracy. Similarly, small- to medium-hub airports that are initially directed to the Intermediate Approach can elevate the outcomes of the assessment to the Advanced Approach level.

Note: After selecting an approach, *Guidebook* users should re-review Section 3.2 to ensure that all the factors have been considered, proper weights have been given to each one, and that none of the special circumstances in Table 3.2 have been overlooked.

CHAPTER 4

How to Prepare an Airport Emissions Inventory for an SIP



Note: QA/QC = quality assurance/quality control.

Figure 4-1. Steps to preparing an airport emissions inventory.

This chapter offers guidance on how to prepare airport emissions inventories in support of SIPs. It is envisioned that this process can be applied by *Guidebook* users to all types of airports, nonattainment pollutants, and SIPs.

For simplicity and ease of understanding, Figure 4-1 lists the nine recommended steps, from start to finish, for preparing an airport emissions inventory. It also serves as a guidepost for describing the individual elements of the process in the following sections. However, it is recognized that the applicability and sequence of each step will vary on a case-by-case basis and/or may be determined to be unnecessary altogether.

4.1 Identify Pollutants of Concern (Step 1)

As described in Chapter 2, nonattainment and maintenance designations are assigned to areas that do not meet the NAAQS for any of the U.S. EPA's criteria air pollutants (e.g., CO, NO_2, etc.). It is further discussed in that section that SIPs are purposely developed to help bring these areas into attainment—focusing on those pollutants-of-concern (and their precursors) that caused or contributed to the violation(s).

For example, SIPs for CO nonattainment or maintenance areas contain strategies for controlling emissions of this localized pollutant. By comparison, SIPs for O_3 nonattainment areas are aimed at controlling emissions of NO_x and volatile organic compounds (VOCs)—the two principal precursors to the formation of this regional pollutant.

As a matter of consistency, airport emissions inventories prepared for SIPs should contain emissions data for those pollutant species for which an area is declared nonattainment or maintenance. In other words, within CO maintenance areas, airport-related emissions of CO are the most relevant. In contrast, for O_3 nonattainment areas, airport-related emissions of NO_x and VOCs are the most pertinent.

For ease of interpretation, Figure 4-2 provides an alphabetical listing of all six U.S. EPA criteria pollutants potentially subject to an SIP along with summary explanations of how these pollutants-of-concern (and their precursors) are typically reported as airport-related emissions. As shown, for the pollutants CO, lead, PM_{10} and $PM_{2.5}$, the specific compound, or species, are computed; for NO_2 and SO_2, the broader categories of NO_x and SO_x are reported; and for O_3, the precursor emissions of NO_x and VOCs are the pollutants-of-concern and are reported.

4.2 Identify and Name Airports (Step 2)

Among the most significant deficiencies uncovered in the review of existing SIPs was the inability to distinguish which airports were accounted for in the emissions inventories. As discussed in Chapter 1, the majority of SIPs reviewed by the research team only identified the prin-

Carbon Monoxide (CO)	• Most former CO nonattainment areas are maintenance areas. • Airport-related emissions of CO are in decline.
Lead (Pb)	• Nonattainment areas are localized around specific sources. • GA aircraft using leaded fuels are an important source.
Nitrogen Dioxide (NO_2)	• SIPs address emissions of NO_2 as nitrogen oxides (NO_x). • By-product of high temperature/pressure aircraft engines.
Ozone (O_3)	• Most common nonattainment pollutant across the U.S. • Airport emissions include O_3-forming precursors of NO_x and VOCs.
Particulate Matter (PM)	• Two size ranges with NAAQS: PM_{10} & $PM_{2.5}$ • Airport emissions include $PM_{10/2.5}$ and their precursors.
Sulfur Dioxide (SO_2)	• SIPs contain emissions of SO_2 as SO_x. • Airports are not considered significant sources.

Figure 4-2. U.S. EPA criteria pollutants.

cipal airport(s) as being included or referred to airport-related emissions generically without naming any individual facilities. In other cases, the research revealed that some airports were inadvertently omitted from the inventories altogether. This oversight makes it difficult to segregate emissions between airports located in the same nonattainment/maintenance areas or to ensure that all airport emissions are accounted for in the SIP.

Therefore, under this step, it is suggested that *Guidebook* users purposely identify and name the airport(s) that are to be included in the SIP and maintain this practice throughout the emissions inventory preparation and reporting processes.

4.3 Identify Sources of Emissions (Step 3)

As shown in Figure 4-3, airports characteristically represent a diverse aggregate of emissions sources: however, principal among these are aircraft, APUs, and GSE. By comparison, other, smaller sources of emissions also occur such as passenger, cargo, and employee motor vehicles; fuel storage facilities; and a wide assortment of stationary sources (e.g., back-up generators, boilers, etc.). Notably, construction-related emissions associated with the development of airport improvement projects are also considered as an airport-related source under the CAA General Conformity Rule.

However, as discussed in Chapter 1, this *Guidebook* focuses on preparing emissions inventories for aircraft, APUs, and GSE as these airport-related sources are the most significant and most commonly accounted for in SIPs. Figure 4-4 and the following sections provide further details regarding these three sources of airport emissions.

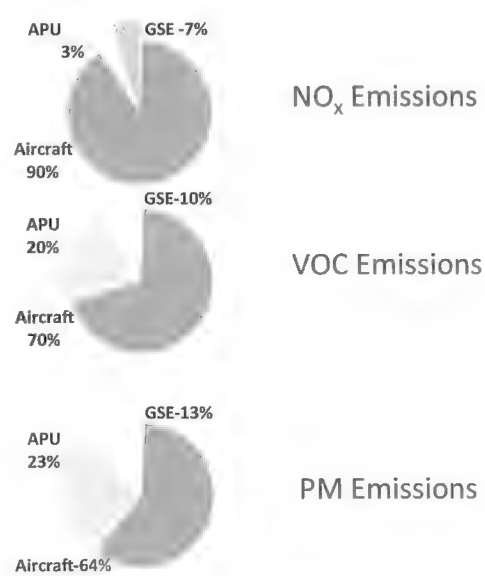
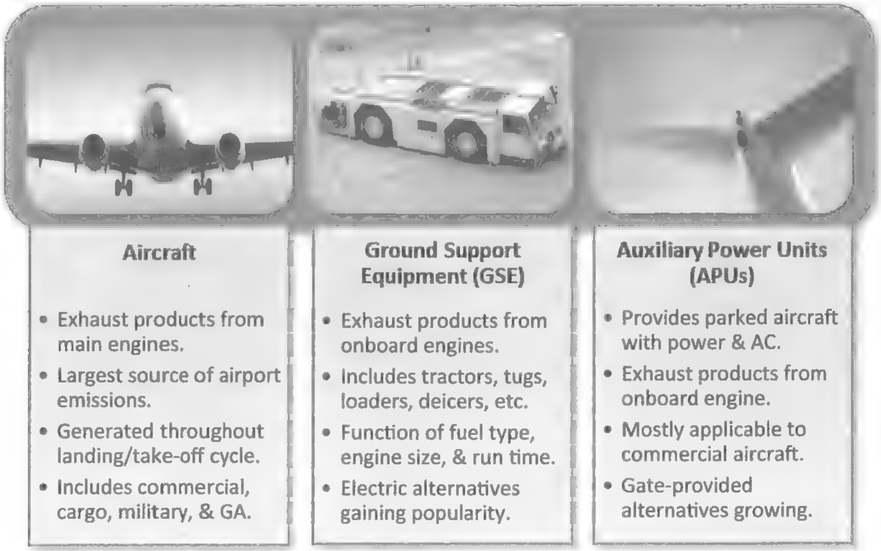


Figure 4-3. Airport emissions sources.



Note: AC = air conditioning (heating and cooling).

Figure 4-4. Aircraft, GSE, and APU emissions characteristics.

4.3.1 Aircraft

Aircraft emissions primarily consist of the fuel-based exhaust products from the aircraft's main engines. For airport emissions inventories, these emissions are calculated throughout the landing and takeoff (LTO) cycle, which encompasses the aircraft's final approach, landing, roll, and taxing in to the terminal area while inbound, and the engine restart, taxing out, takeoff, and climb out during the outbound segment.

Within the aircraft LTO cycle, emissions are mainly a function of the number of operations (i.e., LTOs); the aircraft fleet characteristics (i.e., aircraft type, number of engines, and take-off weight); and the aircraft engine operating features (i.e., fuel flow rates and emissions factors). The effects of the individual airport operating conditions and local atmospheric mixing height on the LTO time also play a role. As discussed in Chapter 3 and restated below, the approach to preparing an airport emissions inventory (i.e., Basic, Intermediate, Advanced) determines which of these data inputs are ultimately required as well as the level of detail needed to perform the emissions calculations.

4.3.2 Ground Support Equipment (GSE)

Ground support equipment (GSE) typically consists of the assortment of vehicles and equipment that service aircraft while parked at gates, in hanger areas, or on airport aprons. Representative examples of GSE include aircraft pushback tractors and baggage tugs; deicing, fueling, and catering trucks; belt and cargo loaders; and passenger/employee transport vehicles operating on the airside of the airport.

GSE utilization and activity levels vary by airport type (e.g., commercial versus GA), aircraft type (e.g., wide body versus narrow body), payload (e.g., passengers versus cargo) and climatic conditions (e.g., cold versus warm). GSE emissions also vary by

Reference: *ACRP Report 78: Airport Ground Support Equipment (GSE) Emission Reduction Strategies, Inventory and Tutorial* contains information and data pertaining to GSE fleet populations, emissions, and operating characteristics at U.S. airports.

fuel type (e.g., diesel, gasoline, propane, electric, etc.), model year, and horsepower rating. Again, the selected emissions inventory approach (i.e., Basic, Intermediate, Advanced) determines which GSE data are necessary to compute emissions from this source.

References: ACRP Project 02-17, "Measuring PM Emissions from Aircraft Auxiliary Power Units, Tires and Brakes" and *ACRP Report 64: Handbook for Evaluating Emissions and Costs of APUs and Alternative Systems* both contain new data and information on APUs.

4.3.3 Auxiliary Power Units (APUs)

Auxiliary power units (APUs) are turbine engines located onboard many commercial and cargo aircraft and are used to start the main engines and provide power to the aircraft electrical equipment (including the air conditioning systems) when aircraft are taxiing or are parked at gates or apron areas.

As with the aircraft main engines, APU emissions are primarily a function of engine type and operating time. If available, aircraft can also obtain power and pre-conditioned air (PCA) from either mobile ground power units (GPU) or from hook-ups at the terminal gate, thereby reducing the need for APUs.

Reference: *ACRP Project 02-33, "Guidance for Estimating Airport Construction Emissions"* provides guidance on calculating airport-related construction emissions.

4.3.4 Other Sources of Emissions

In addition to aircraft, APUs, and GSE, other emissions sources also commonly exist at airports and typically consist of motor vehicles traveling to, from, and within the site; fuel storage and transfer facilities; and a wide assortment of stationary sources, including steam boilers, emergency generators, and/or fire training facilities. Construction-related activities and equipment associated with airfield and terminal area improvement projects are also considered to be a source of airport emissions.

However, motor vehicle, stationary, and construction sources of emissions are usually accounted for separately in SIPs and therefore are considered outside the scope of this *Guidebook.* For example, emissions from off-airport motor vehicle traffic (i.e., cars, vans, and busses) are commonly accounted for in mobile source emissions inventories developed for region-wide roadway networks/systems. Many stationary sources at airports are individually permitted to operate by state/local agencies and thus their emissions are routinely documented. With a few exceptions, construction-related emissions at airports are presently not quantified or reported in SIPs.

4.4 Identify Emissions Inventory Timeframes (Step 4)

As discussed in Chapter 2, SIPs incorporate specific timeframes for enacting emission reduction strategies, meeting interim objectives, and demonstrating progress toward attaining the NAAQS. In support of this approach, the emissions inventories contained in the SIP are typically computed for historic, existing, and/or future-year timeframes based upon when the nonattainment designations were originally established, the pollutant(s)-of-concern, and the degree of noncompliance.

For overall consistency, ease of coordination, and aid in adoption, the airport emissions inventory should be computed for the same time periods identified in the SIP that serve as important benchmarks, milestones, and endpoints. Figure 4-5 broadly describes these targeted timetables. Early coordination between airport operators and

SIP Time Periods

Historic

Characterizes conditions that existed when the nonattainment designation was originally established and serves as the baseline upon which the requisite emissions control targets and strategies to meet the NAAQS are set.

Existing

Corresponds to existing (or recently past) conditions in the nonattainment area and serves as a milestone toward achieving the objectives of the SIP and attaining (or maintaining) the NAAQS.

Future

Represents milestones and forecasted conditions when attainment of the NAAQS is expected to be achieved. Time intervals vary by original nonattainment designation date, pollutant(s)-of-concern, and the degree of nonattainment.

Figure 4-5. Emissions inventory timeframes.

air quality regulatory agencies will help ensure that airport emissions inventories are aligned with these SIP milestones.

4.5 Select an Emissions Inventory Approach (Step 5)

Chapter 3 describes three alternative approaches for preparing airport emissions inventories for SIPs. As discussed, each approach reflects a number of features that are viewed as central to preparing the inventory and, when combined together, are easily defined, but also distinct from one another. Presented in increasing order of relative complexity, data needs, and relative accuracy, the three approaches (i.e., Basic, Intermediate, Advanced) are depicted in Figure 4-6 with their most prominent characteristics highlighted and further described below.

- **Basic Approach**—This approach requires the least amount of input data but purposely produces conservatively high results—making it the least accurate. This approach is best suited for non-hub commercial and GA airports with less than 100,000 annual operations and is the basis for the *Airport Emissions Estimator Tool* developed as a companion to this *Guidebook* (see Appendix C) (All Appendices, the *Airport Emissions Estimator Tool,* and other supporting materials are available on the accompanying CD and online at www.trb.org, search for "Guidebook for Preparing Airport Emissions Inventories for State Implementation Plans").
- **Intermediate Approach**—This approach is viewed as transitional between the Basic and Advanced approaches, producing results with a higher level of accuracy than the former while requiring less input data than the latter. Based upon airport-specific operational, aircraft fleet mix and airfield operational data, combined with an assortment of EDMS-default databases for GSE and APU usage, this approach is considered suitable for large GA and small- to medium-hub commercial airports located in moderate nonattainment and maintenance areas.
- **Advanced Approach**—This approach produces an emissions inventory with the highest levels of airport specificity, is the most data intensive, and is considered to be the most accurate. This approach is best suited for large-hub commercial airports and airports located in serious to severe nonattainment areas but can also be applied to small- to medium-hub and GA airports where advanced levels of precision and airport specificity are desired.

Reminder: When computing airport emissions inventories, accurate and airport-specific results are preferred over generalized or conservatively high estimates. However, other factors and considerations may impede this objective.

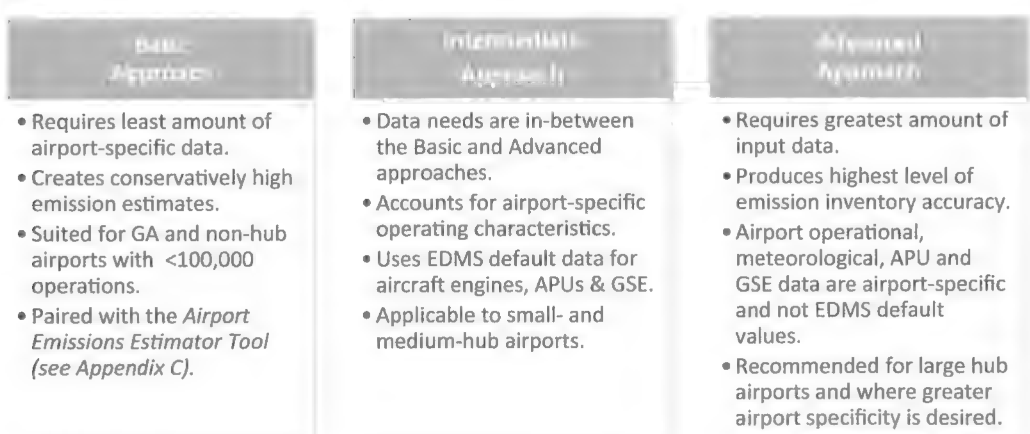


Figure 4-6. Airport emissions inventory approaches.

Chapter 3 also identifies a number of important considerations, or factors, which will likely be evaluated and decided upon by the preparers of airport emissions inventories in choosing an approach. These include the expertise of the preparer; the area nonattainment designation; the airport type, function, and activity level; and the benefits/costs to conduct the analysis. The principal advantages and disadvantages of each approach are also identified and discussed. Finally, a decision-tree diagram is provided to aid *Guidebook* users in the approach selection process.

4.6 Collect/Develop Input Data (Step 6)

In the five preceding steps, *Guidebook* users are first advised to consider (1) the pollutant(s)-of-concern for the nonattainment/maintenance area, (2) the individual airports to be included, (3) the airport emissions sources, (4) the assessment time periods, and (5) the alternative approaches for preparing airport emissions inventories for SIPs. In this way it is expected that the subsequent steps (Steps 6 through 9), which are, by comparison, more data- and labor-intensive, can be accomplished more deliberately and effectively.

Presented separately according to the three alternative approaches (e.g., Basic, Intermediate, Advanced) contained in this *Guidebook*, this section describes the input data and supporting information considered necessary for preparing an airport emissions inventory. For consistency, these data needs are individually listed in Table 4-1–segregated by approach emissions source (i.e., aircraft, APUs, and GSE) and input parameter (e.g., fleet mix, operating time, etc.).

4.6.1 Basic Approach Data Needs

As previously discussed, the Basic Approach is the simplest approach for computing an airport emissions inventory and requires the least amount of input data. The data needs only constitute (1) the airport's aircraft operational levels and (2) a generalized aircraft fleet mix. Conservative

Table 4-1. Airport emissions inventory data needs.

Data Needs	Approach		
	Basic	Intermediate	Advanced
Aircraft			
• Operations	✓	✓	✓
• Fleet Mix	✓	✓	✓
• Times-In-Mode		✓	✓
• Engine Type			✓
Auxiliary Power Units			
• Assignment			✓
• Operating Time			✓
Ground Support Equipment			
• Equipment Type			✓
• Fuel Type			✓
• Aircraft Type			✓
• Operating Time			✓
Meteorology			
• Mixing Height		✓	✓
• Ambient Temperature		✓	✓

assumptions regarding the aircraft engine assignments, airfield taxi/delay times, and APU/GSE use are inherent to this approach and therefore these input data are not required.

To facilitate the preparation of an airport emissions inventory using the Basic Approach, an *Airport Emissions Estimator Tool* has been developed as a companion to this *Guidebook* (see Appendix C).

The sources for the input data for the Basic Approach and the *Estimator Tool* are briefly discussed below. For ease of reference, Table 4-2 provides references to Appendix B where additional details on these input data and their sources may be obtained.

Table 4-2. Basic approach input data.

	Aircraft	
Time Period	Operations	Fleet Mix
Historic/ Existing	*Appendix B Figure B-2 & Table B-1*	*Same as Operations*
Future	*Appendix B Figure B-3 & Table B-2*	*Same as Operations*

- **Aircraft Operations**—For the Basic Approach, aircraft operations input data are subdivided among four operational categories: (1) air carrier, (2) air taxi/commuter, (3) general aviation and (4) military. These data are most easily obtainable for those airports within the FAA's National Plan of Integrated Airport Systems (NPIAS) that have an airport traffic control tower (ATCT). For these airports, FAA databases such as the Air Traffic Activity Data System (ATADS) and the Terminal Area Forecast (TAF) contain annual operational data. Other recommended data sources include a current Airport Master Plan, a Federal Aviation Regulations (FAR) Part 150 Noise Study, or an Environmental Impact Statement/Assessment (EIS/EA) for the airport(s) of interest, if they are up to date and available. For NPIAS airports without an ATCT, again, a recent airport-specific study or the TAF are likely sources of data, where available.

  For non-NPIAS airports, or in those cases where the above-mentioned data sources are unavailable for an NPIAS airport, a recent airport study, the airport's Form 5010 Airport Master Record (AMR), or an Airport System Plan (ASP) prepared by a state/local transportation agency may contain operational data for the airport(s) of interest.

  For future-year operational data, *Guidebook* users are similarly directed to either a recent airport study or the TAF for NPIAS airports (with and without an ATCT) and to an ASP or the *FAA Aerospace Forecast* for all other airports.
- **Aircraft Fleet Mix**—As discussed above, the airport operational data for the Basic Approach are segregated into (1) air carrier, (2) air taxi/commuter, (3) general aviation and (4) military categories. Accordingly, the same sources identified for these aircraft operations data also provide the aircraft fleet mix.

For further reference, Appendix C describes how the *Estimator Tool* was developed and provides the outcome of an analysis demonstrating the conservative nature of the tool's results.

Reminder: When using FAA or airport-specific sources for aircraft operational and fleet mix data, it may be important to note whether the data is for the calendar- or fiscal-year time period.

Reference: Appendix C describes how the Emissions Estimator Tool was developed and provides the outcome of an analysis demonstrating the conservativeness of the results.

Idea: Early coordination between airport operators and air quality regulatory agencies will help ensure that airport emissions inventories are aligned with significant SIP milestones discussed in Chapter 2.

4.6.2 Intermediate Approach Data Needs

As discussed previously, the Intermediate Approach involves direct use of the FAA's EDMS. Input data include the level of aircraft operations and the fleet mix; however, for the Intermediate Approach, the details for these two primary parameters are greater than for the Basic Approach. Again, for ease of reference,

Table 4-3. Intermediate approach input data.

	Aircraft			Meteorology
Time Period	Operations	Fleet Mix	Times-In-Mode	Mixing Height
Historic/ Existing	*Appendix B Figure B-2 and Table B-1*	*Appendix B Figure B-4, Tables B-3 and B-5*	*Appendix B Table B-6*	National Climatic Data Center (NCDC) or Local Agency
Future	*Appendix B Figure B-3 and Table B-2*	*Appendix B Table B-4*	*Appendix B Table B-6*	NCDC or Local Agency

the input data required for the Intermediate Approach are listed in Table 4-3, including references to Appendix B where the data sources are identified, and are discussed below.

- **Aircraft Operations**—Under this approach, aircraft operations input data are the same as those identified for the Basic Approach. That is, ATADS and the TAF contain these data for NPIAS airports with an ATCT. Again, recent airport studies (e.g., Airport Master Plan, Part 150 Study, EIS/EAs) are also recommended sources for these data.

  However, unlike the Basic Approach, these aircraft operations input data must be segregated in EDMS by aircraft type (e.g., Boeing) and model (e.g., 737-700 series) under this approach. Examples of these data sets are provided in Table 4-4.
- **Aircraft Fleet Mix**—As with the aircraft operational data discussed above, the aircraft fleet mix are also segregated by aircraft type and model. However, to achieve the fleet mix level of detail shown in Table 4-4, a variety of additional data sources may be required to obtain the engine model (explained further below).

  Commercial service airport data sources include (but are not limited to) a recent airport study, an Airport Noise and Operations Monitoring System (ANOMS), the U.S. Bureau of Transportation Statistic (BTS) Schedule T-100, and FAA's Enhanced Traffic Management System Counts (ETMSC). For future-year fleet mix data, it is suggested that *Guidebook* users consult a recent Master Plan Study and/or the FAA Aerospace Forecast for the airport(s).

Table 4-4. Example EDMS aircraft model, engine, & operations input data.

Category	Model	Engine	Operations
Air Carrier	Airbus A320-200 Series	V2527-A5	1,500
	Boeing 727-200 Series	JT8D-15	4,000
	Boeing 767-200 Series	CF6-80A	500
	Airbus A320-200 Series	V2527-A5	2,500
Air Taxi/ Commuter	Embraer ERJ145	AE3007A1E	10,000
	Saab 340-A	CT7-5	5,000
	Gulfstream G500	BR700-710A1-10	6,500
	Bombardier CRJ-200	CF34-3B	7,500
GA	Bell 206 JetRanger	250B17B	1,200
	Bombardier Learjet 45	TFE731-2-2B	2,400
	Cessna 750 Citation X	AE3007C Type 2	500
	Piper PA-31 Navajo	TIO-540-J2B2	3,600
Military	Boeing F/A-18 Hornet	F404-GE-400	700
	Boeing KC-135 Stratotanker	CFM56-2A series	2,500

For GA airports, a recent airport study, ATCT flight strips/counters, and fixed-base operator logs may contain these aircraft fleet mix data.

- **Aircraft Engine Type**—It is the intent of the Intermediate Approach to use the EDMS "default" engine information. For example, within EDMS the default engine for a Boeing 737-700 series is the CFM56-7B22 engine. However, not every aircraft in EDMS has a "default" engine selection available. In these instances, the Official Airline Guide (OAG) Aviation Database and the JP Airline-Fleets International Database (JP Fleets) can be consulted.
- **Aircraft Times-In-Mode**—Airport-specific taxi-in and taxi-out times can be obtained from FAA's Aviation System Performance Metrics (ASPM) and the BTS On-Time Statistics, if this information is available. Although EDMS offers "default" taxi times for a variety of aircraft types, the application of airport-specific taxi times by this *Guidebook* users can greatly improve the emissions inventory estimates.
- **Meteorology**—Under the Intermediate Approach, EDMS is run in the "performance" mode, which automatically adjusts the aircraft times-in-modes during the approach, takeoff, and climbout periods based on other parameters defined by the user (e.g., atmospheric mixing height, temperature, relative humidity, and elevation).

  For the atmospheric mixing height, which defines the vertical limit of the aircraft LTO, EDMS uses a default value of 3,000 feet above ground level (AGL) if the user does not define an airport-specific value. *Guidebook* users can contact the state/local air agency to determine if a more appropriate mixing height should be used to develop the SIP airport emissions inventory.

Note: When using EDMS, there is no single resource of input data for computing airport emissions. Rather, several sources of data must be consulted and, in some cases, the data processed.

Note: Under the Intermediate Approach, *Guidebook* users have the option of using EDMS default data or airport-specific data for ground-based taxi times and atmospheric mixing height.

4.6.3 Advanced Approach Data Needs

The Advanced Approach also involves the use of the FAA's EDMS but takes much greater advantage of the model's ability to produce results that are airport specific. In addition to modeling the airport's operational levels, aircraft fleet mix and airfield operating conditions in more detail than the Intermediate Approach, this approach also accounts for the airport's unique GSE and APU fleets and operating characteristics.

Again, for ease of reference, the input data required for the Advanced Approach are listed in Table 4.5, including references to Appendix B where these data sources are identified and are discussed below.

- **Aircraft Operations**—For the Advanced Approach, the sources of aircraft operations input data are essentially the same as those identified for the Intermediate Approach and include ATADS and the TAF for NPIAS airports with an ATCT. Recent airport studies (e.g., Airport Master Plan, Part 150 Study, EIS/EA's) and airport simulation models, such as SIMMOD and TAAM, are again recommended sources of these data.

Key Point: When preparing a future-year airport emissions inventory, the aircraft operational forecasts are "key." As discussed in *ACRP Synthesis 2: Airport Aviation Activity Forecasting* and *Appendix B* of this report, these forecasts are based upon parameters that are time-sensitive and subject to change.

Therefore, this *Guidebook* suggests that these future-year forecasts be adjusted using the "TAF+10" approach, whenever justified. For example, for a 2015 emissions inventory, use 2025 TAF operational levels; for 2020, use 2030 operational levels, etc. (see Appendix E).

In this way, estimates of future-year emissions are conservatively high enough to account for the uncertainty inherent to these forecasts but not overly conservative resulting in an emissions inventory that is entirely disproportionate or in other ways wholly misrepresentative of potential conditions.

Table 4-5. Advanced approach input data.

	Aircraft				Meteorology	
Time Period	Operations	Fleet Mix	Times-In-Mode	Engine Type	Mixing Height	Ambient Temperature
Historic/ Existing	Airport Data *Appx B, Fig. 2*	Existing Operational Data *Appx B, Fig. 4*	FAA Databases or Simulation Models	EDMS or OAG/JP Fleets	NCDC or Local Agency	NCDC
Future	Airport Data *Appx B, Fig. 3*	Future Operational Data *Appx B, Fig. 3*	FAA Databases or Simulation Models	EDMS or OAG/JP Fleets	NCDC or Local Agency	NCDC

	Ground Support Equipment				Auxiliary Power Units	
Time Period	Equipment Type	Fuel Type	Aircraft Type	Operating Time	Assignment	Operating Time
Historic/ Existing	Airport Data	Airport Data	EDMS (Default)	Airport Data or EDMS	Airport Data or EDMS	Airport Data or EDMS
Future	Airport Data	Airport Data	EDMS (Default)	Airport Data or EDMS	Airport Data or EDMS	Airport Data or EDMS

For future-year operational levels, FAA-approved forecasts are contained in the TAF for NPIAS airports with ATCTs. Greater details are also contained in airport-specific studies where available, and may account for airport plans that are unaccounted for in the TAF. Forecast studies prepared for smaller GA airports tend to rely on trend extrapolation or market share analyses.

- **Aircraft Fleet Mix**—Under this approach, the aircraft fleet mix data should enable the identification of aircraft/engine combinations as discussed previously, as well as other parameters that reflect aircraft movement throughout the airfield (i.e., which gates, runways, and taxiways are utilized during an aircraft LTO cycle). To this end, simulation models such as SIMMOD or TAAM, supplemented with Intermediate Approach data sources including ANOMS, BTS Schedule T-100, ETMSC, and data from OAG Aviation or JP Fleets should be used. Used in conjunction, these data sources can provide insight on the level of operations by aircraft category (e.g., air carrier), airframe model (e.g., Airbus A320-200), and engine (e.g., V2527-A5), all of which are required inputs under this approach.

  It is also recommended that the future-year aircraft fleet mix used under the Advanced Approach should account for the future replacement of older aircraft with newer aircraft. These data can be derived using industry-wide forecasts or airport-specific studies.
- **Times-In-Mode**—As discussed above, the Advanced Approach requires the use of EDMS in its "performance" mode. However, in addition to the ASPM or BTS for airport-specific taxi times, *Guidebook* users can consider using the output from airfield simulation modeling analyses (e.g., SIMMOD, TAAM, or EDMS's Delay and Sequence Module).

  Under the Advanced Approach, the user can also consider adjusting aircraft takeoff and/or approach weights in the EDMS to increase the accuracy of the emissions estimate for the takeoff, climbout, and approach modes of the aircraft LTO.
- **Meteorology**—Users of the Advanced Approach have the option of using hourly meteorological data (surface and upper air data from the NCDC) instead of "default" average weather

data contained in EDMS. The atmospheric mixing height can also be determined from NCDC databases or by consulting the state/local agency preparing the SIP.

- **Ground Support Equipment**—Airport-specific GSE fleet data can be obtained from in-the-field surveys and/or equipment inventories compiled by the airport operator, airlines, cargo carriers, and GSE providers. Information pertaining to the GSE type (e.g., baggage tractor, deicer, belt loader, etc.); horsepower; manufacturer, model, and year; and fuel type are useful inputs for users adhering to the Advanced Approach. GSE utilization data by aircraft size/type (e.g., narrow body, wide body, and commuter) and operating time are also desirable.

  Terminal area gate infrastructure such as hydrant systems or preconditioned air (PCA) units should be noted during the field surveys, as these devices typically reduce the usage and operating conditions of some GSE such as fuel trucks and portable air conditioners.

  Finally, cargo, GA, and military GSE usage should also be surveyed if these types of operations represent a large proportion of the total aircraft operations at the airport.

Idea: Airport-specific data collected on GSE and APU use can improve emissions estimates from these sources significantly.

- **Auxiliary Power Units**—For aircraft that use APUs (i.e., commercial and commuter), EDMS automatically assigns an APU make and model and by default assigns the APU an operating time of 13 minutes on arrival and 13 minutes on departure—for a total of 26 minutes per LTO cycle. However, under the Advanced Approach, airport-specific APU operating times should be considered. If in-the-field surveys reveal ground power/gate power and PCA are available at the airport, the assumed APU operating times and their emissions can be reduced significantly.

For some nonattainment SIPs, air quality agencies will use the airport emissions inventory results as input data to atmospheric dispersion models such as the Urban Airshed Model. In these instances, additional data describing the temporal and spatial characteristics of the airport-related emissions are called for, as follows:

- **Temporal Profiles**—Temporal profiles describe how aircraft operations vary over time (e.g., monthly, daily, hourly, etc.). These data can be obtained or developed from sources such as the FAA Operations Network (OPSNET) database, ANOMS data, and/or ATCT counts.
- **Spatial Data**—The spatial data describe the geographic and/or vertical locations of the airport-related emissions sources relative to common reference points (e.g., airport centroid or distance above sea level). These data can be obtained from ALPs and/or the Universal Transverse Mercator (UTM) system.

This *Guidebook* is aimed principally at producing airport emissions inventories and, therefore, the additional data requirements for dispersion modeling need to be obtained elsewhere.

4.7 Conduct Emissions Inventory (Step 7)

Upon the completion of the input data development and collection process described above, the airport emissions inventory should be computed. The appropriate method for conducting the inventory is dictated by the selected approach.

Idea: While the nonattainment pollutants (and their precursors) are of primary importance for the SIP, other criteria pollutants can be computed using the *Emissions Estimator Tool* or EDMS with no additional effort.

- **Basic Approach**—To facilitate the preparation of an airport emissions inventory using the Basic Approach, the *Airport Emissions Estimator Tool* has been developed as a companion to this *Guidebook* (see Appendix C). Therefore, it is suggested that *Guidebook* users utilize this Tool for computing the airport emissions inventory under this approach.

- **Intermediate Approach**—The Intermediate Approach involves use of the FAA's EDMS. Therefore, it is suggested that *Guidebook* users utilize EDMS for computing the airport emissions inventory under this approach.
- **Advanced Approach**—The Advanced Approach also involves direct use of the FAA's EDMS and it is again suggested that *Guidebook* users utilize EDMS for computing the airport emissions inventory under this approach.

Note: *EDMS will be replaced by the Airport Environmental Design Tool (AEDT) in 2013. However, this will not change the application of the Guidebook.*

In all three cases, the emissions inventory should be computed for the individual airport(s), time period(s), emissions sources, and pollutant(s)-of-concern identified in Steps 1 through 4 described above. (Note: Air emissions included in the EDMS output but generally not addressed in SIP emissions budgets include carbon dioxide (CO_2), total hydrocarbons (THC), non-methane hydrocarbons (NMHC), and total organic gases (TOG).)

4.8 Conduct QA/QC of Input and Output Data (Step 8)

Because the preparation of an airport emissions inventory involves the development and processing of input data, selecting among alternative choices or commands and interpreting results, unforeseen errors can occur. Failure to identify and correct these errors will result in an over- or underestimation of emissions from airport-related sources. Therefore, it is suggested that *Guidebook* users perform QA/QC procedures on both the input data and the results prior to incorporating the airport emissions inventory into SIPs.

Table 4.6 provides a listing of some of the most common errors that are expected to occur when preparing airport emissions inventories. Also shown are the resultant consequences and the remedies to these errors.

Table 4-6. Common errors when preparing airport emission inventories.

Error	Consequence	Remedy
	Airport Operational Levels	
Operations are not converted to LTO cycles or vice versa.	Emissions are over- or under-estimated.	Make proper conversions. (2 operations = 1 LTO)
	Aircraft Fleet Mix	
Incorrect aircraft/aircraft engine combination selected (Advanced)	Aircraft emissions are over- or underestimated.	Check and correct input data, if necessary.
	Atmospheric Mixing Height	
Default value of 3,000 feet is used when another value is more appropriate (Inter./Adv.)	Aircraft emissions are over- or underestimated.	Coordinate with state/local agency for correct mixing height values.
	GSE & APU Input	
Default GSE fleet mix selected for one or more aircraft types (Adv.)	GSE emissions are over-estimated.	Check and correct input data, if necessary.
Default APU assignments selected for aircraft types (Adv.)	APU emissions overestimated.	Check and correct input data, if necessary.
	EDMS Set Up	
Metric units are selected instead of English units (Inter./Adv.)	Resulting emissions computed as metric- instead of short-tons.	Check and correct input data, if necessary.
Incorrect analysis year selected in EDMS (Inter./Adv.)	GSE emissions are overestimated since emission factors for GSE are based on NONROAD modeling for specific years.	Check and correct input data, if necessary.

Note: Inter. = Intermediate, Adv. = Advanced.

Table 4-7. Example airport emissions inventory reporting format.

Airport "Y"	Emissions "X"		
	Year "1"	Year "2"	Year "3"
Source Category			
Aircraft			
• Aircraft Engines	-	-	-
• Auxiliary Power Units (APUs)	-	-	-
Aircraft Totals	--	--	--
• Ground Support Equipment (GSE)	-	-	-
Airport Totals	---	---	---

4.9 Document and Report Results (Step 9)

Once the *Guidebook* user has prepared an airport emissions inventory using one of the three recommended approaches (i.e., Basic, Intermediate, Advanced), the results should be tabulated, documented, and prepared for inclusion in the SIP. However, because air quality regulatory agencies use a variety of means for recording airport-related emissions in SIPs, airport/agency coordination on this matter is suggested as discussed in Chapter 5.

As a means of harmonizing the documentation and reporting methods, Table 4-7 provides a simplified example format for compiling the emissions inventory data. This format can be modified and/or expanded upon as necessary to meet the needs of the stakeholders. Nevertheless, the emphasis should be placed on identifying the airport(s), pollutant type(s), emissions sources, and time period(s) that the emissions inventory results represent.

For clarification, the terms used in Table 4.7 are defined as follows:

- **Emissions "X"**—These are the pollutant(s)-of-concern for the nonattainment/maintenance area for which the SIP applies (see Section 4.1). These consist of the U.S. EPA criteria pollutants and/or their precursors: "X" = CO, NO_x, VOCs, etc.
- **Airport "Y"**—This is the name of the airport for which the airport emissions are computed (see Section 4.2): "Y" = airport name.
- **Source Category**—These are the emissions sources that are included in the airport emissions inventory (see Section 4.3). These sources consist of aircraft, APUs, and GSE.
- **Year**—This is the historic, existing, and/or future year for which the airport emissions are computed (see Section 4.4). As discussed, the airport emissions inventory should coincide with the same time periods identified in the SIP that serve as important benchmarks, milestones, and endpoints. Years "1," "2," and "3" represent the years of the emissions inventory (e.g., 2012, 2015, etc.).
- **Totals**—These values represent the subtotals and totals of the emissions inventory by source category, pollutant type, and year. For SIP purposes, the reporting units are typically in tons per year but can vary (e.g., metric tons per year, pounds per day, kilograms/day, etc.).

Idea: As discussed in Chapter 5, coordination between airport operators and air quality regulatory agencies will help ensure that airport emissions inventories are properly documented and recorded in the SIP.

Supporting documentation for the airport emissions inventory is recommended and should include a listing or description of the overall approach, data sources, and assumptions that were relied upon to complete the analysis. This information and data can be summarized in a brief technical memorandum or as a detailed technical report.

CHAPTER 5

SIP Coordination Strategies and Best Practices

Coordination between airport operators and air quality regulatory agencies is essential to ensure that airport-related emissions are appropriately and accurately accounted for in SIPs. Therefore, this chapter presents recommended approaches and best practices that these stakeholders can undertake to achieve this goal. For consistency and ease of understanding, the SIP Development Process initially described in Chapter 2 is used as the framework upon which these practices can be most effectively implemented.

5.1 SIP Development Process

As described previously in this *Guidebook,* the SIP Development Process typically progresses from initiation to implementation over four distinct and sequential stages: (1) Planning, (2) Preparation, (3) Adoption, and (4) Approval. This process can take a year or more to complete depending on the pollutant(s)-of-concern, the degree of nonattainment, and the emissions control measures required to reach attainment. The descriptions of these stages, or phases, are listed in Table 5-1 and expanded upon in this section with the principal aim of recommending when airport/agency coordination can be the most appropriate and effective.

5.1.1 SIP Planning Phase

During the SIP Planning Phase, state and/or local air quality agencies first identify all of the emissions sources located in the nonattainment area to be included in the SIP. Typically, these sources include (but are not limited to) a wide array of commercial, industrial, and manufacturing facilities; an assortment of mining, agricultural, and construction activities; and a variety of transportation sources (e.g.., motor vehicles and marine/rail/aircraft sources). For continued assessment and accounting purposes, these emissions sources are generally allocated in the SIP among three broad categories (i.e., stationary, area, and mobile) and further segregated into subcategories (e.g., petrochemical is a subcategory within the area of stationary emissions sources).

Following the identification of the emissions sources to be included in the SIP, the state/local agencies undertake an initial determination of the appropriateness and availability of the input data considered necessary for preparing emissions estimates. Based upon the outcome, the agency develops a Data Collection Plan (i.e., Inventory Preparation Plan (IPP) or Technical Analysis Protocol (TAP)) designed to fill the current gaps in the available data and information.

Note: Airport-related emissions sources most commonly included in SIPs (e.g., aircraft, APU, and GSE) occur predominantly in the Mobile Source, Nonroad subcategory.

As shown in Table 5-1, there are at least two opportunities during this SIP Planning Phase for airports and agencies to coordinate on

Table 5-1. Opportunities for airport/agency coordination during the SIP development process.

Agency	SIP Task	Airport/Agency Coordination
	1. Planning Phase	
State/Local	Identify emissions sources to include in SIP.	Conduct coordination on which airports and/or airport sources to include in SIP.
	Obtain available information and identify data gaps for preparing SIP.	Conduct coordination on airport-related data needs and availability for SIP emissions inventory.
	Develop *Data Collection Plan*.	-
	2. Preparation Phase	
State/Local	Complete data collection, prepare emissions inventories, and conduct modeling.	Airport provides airport emissions inventory and/or supporting data for SIP.
	Develop emission reduction/control measures.	Evaluate airport-related emission reduction proposals in SIP (if applicable).
	Prepare Draft SIP demonstrating attainment of NAAQS.	Review SIP airport emissions inventory and supporting materials for adequacy.
	3. Adoption Phase	
State/Local	Conduct public review and comment period.	Coordinate in response to aviation-related comments in SIP (if applicable).
	Prepare final SIP.	-
	Submit to U.S. EPA for review.	-
	4. Approval Phase	
U.S. EPA	Conduct adequacy review and determine completeness.	-
State/Local	Establish attainment timeframe and milestones.	-
U.S. EPA	Conduct legal sufficiency review.	-
	Publish notice of Final SIP in *Federal Register*.	-

the SIP Development Process. They include (1) identifying the airports in the nonattainment area to include in the SIP and (2) assessing data needs and data availability related to the airport emissions inventories.

5.1.2 SIP Preparation Phase

During the SIP Preparation Phase, the state/local agencies undertake the data collection processes by assembling the available data, information, and supporting materials identified and deemed necessary during the Planning Phase for preparing the SIP. Depending on the source types and emissions characteristics, these data may include (but, again, are not necessarily limited to) the location, size, operating conditions, pollutant types, and control methods of each emissions source or source category.

Using these input data, agencies then prepare comprehensive emissions inventories and conduct atmospheric dispersion modeling in support of formulating the approaches to attaining the NAAQS throughout the nonattainment area. In most cases, the approaches to achieving attainment also involve the development of emission reduction and control measures for the pollutant(s)-of-concern and for the pertinent emissions sources.

Reminder: Airport operational levels can change over time due to a range of economic and regulatory factors and therefore obtaining the most up-to-date data is "key" to producing accurate airport emission inventories.

Ultimately, the outcomes of the SIP Preparation Phase are organized and published by the state/local agency as a Draft SIP. This preliminary document contains the existing (or baseline) and future-year emis-

sions inventories, dispersion modeling results, and the proposed emission reduction/control measures for the nonattainment area and pollutant(s)-of-concern.

As shown in Table 5-1, there are at least three opportunities during this SIP Preparation Phase for airports and agencies to coordinate on the SIP Development Process. They include (1) the airport providing the agency with airport emissions inventories or the appropriate input data from which to compute the emissions; (2) evaluating the appropriateness of any airport-related emission reduction/control measures, should they become necessary; and (3) reviewing the airport components of the Draft SIP to ensure their representativeness and accuracy.

5.1.3 SIP Adoption Phase

During the SIP Adoption Phase the regulatory agencies responsible for preparing the SIP (1) undertake a mandatory public review process, (2) make any necessary changes to the SIP resulting from public input, (3) formally adopt the SIP, and (4) initiate preparations for submittal of the SIP to the U.S. EPA for review and approval. Again, there may be opportunities for airport operators and air quality regulatory agencies to coordinate during this phase of the SIP Development Process.

For example, during the public review process, airport operators can assist the regulatory agencies with responding to any questions or comments related to the airport's emissions inventory.

In addition, during the public review process, it is recommended that airport operators obtain and review the relevant components of the SIP such as the airport emissions inventories and any programs or provisions that potentially affect airport-related activities or sources. If the backup and supporting information used to compute the airport emissions are absent or incomplete, airport operators can request these materials be included in the SIP for reference purposes. Finally, any oversights, discrepancies, or errors that arise from this review should also be identified by the airport operator and reported to the agency along with any necessary clarifications, corrections, and/or alternative remedies.

Note: Airport/agency coordination opportunities on matters pertaining to airport emissions are frequent and meaningful through the SIP Adoption Phase but then they diminish rapidly by the final, SIP approval phase.

In a similarly supporting role, agencies could outreach to airport operators to review and comment upon the appropriate components of the SIP that pertain to aviation. This consultation also applies to agencies seeking specialized expertise and insight from airport operators when addressing public comments on the SIP that pertain to aviation.

5.1.4 SIP Approval Phase

After the Draft SIP is adopted by the state/local air quality agencies, it is submitted to the U.S. EPA for review and approval. With the focus on adequacy and completeness, it is determined if the submitted SIP contains sufficient data and information to demonstrate attainment of the NAAQS. Specifically, the aim is to establish that the SIP emissions inventories, dispersion modeling and control strategies show that the NAAQS will be attained in the nonattainment area by the federally mandated deadlines.

Upon a favorable determination of both completeness and adequacy, the U.S. EPA documents the justifications for approving the Draft SIP and announces its findings in the *Federal Register* for final public review and comment. At the completion of this phase, the Final SIP is implemented and becomes enforceable at both the state and federal levels.

Note: Should state/local agencies fail to prepare an approvable SIP, the U.S. EPA can prepare its own Federal Implementation Plan (FIP) for a nonattainment area.

Figure 5-1. Shared airport & agency air quality responsibilities.

5.2 Airport and Agency Coordination Best Practices

As illustrated in Figure 5-1, both airport operators and air quality agencies share a common interest in managing air emissions within the communities they serve. In both cases, there are ample incentives and opportunities to advance this initiative by ensuring that airport-related emissions are properly accounted for in SIPs. As discussed above, many of these opportunities arise during the SIP Development Process with particularly meaningful benefits to both stakeholders occurring during the SIP Planning, Preparation and Adoption Phases.

Listed in Table 5-2 and discussed in this section, several suggestions on how airport operators and air agencies alike can collaborate and benefit from an SIP coordination process are evident. (Some of the recommendations are further demonstrated with Case Studies in Appendix D) (all Appendices, the *Airport Emissions Estimator Tool,* and other supporting materials are available on the accompanying CD and online at www.trb.org, search for "Guidebook for Estimating Airport Emissions Inventories for State Implementation Plans").

5.2.1 Purpose and Benefits of Coordination

Research conducted in support of this *Guidebook* revealed that the methods and techniques historically used to account for airport-related sources of emissions in SIPs were inadequate or inconsistent (see Appendix A for a discussion of this deficiency.

Table 5-2. Coordination opportunities best practices.

Best Practice	Airport Operator Role	Regulatory Agency Role	Benefits
Introductory Meetings	Educate air agency personnel. Describe how the airport operates, including which sources are under the direct control of the airport operator, the characteristics and frequency of use of each source to be considered, and the potential availability of additional data that may be of use to the air agency.	Describe the framework by which the SIP is being prepared, including objectives, roles, responsibilities and contributions. Prime the airport operator on what data are available, and how data will be used.	Open a line of communication so both parties can understand the intersection of their respective goals and objectives.
Emissions Source Definition	Identify airport emissions sources and define sources with respect to activity, level of airport control, and applicability to the SIP inventory.	Delineate where airport sources fall within the SIP budget and whether they're already covered (to avoid double counting).	Make sure all airport sources are included and evaluated in the proper context.
Protocol Development	Provide step by step guidelines related to emissions calculations for each identified airport source, including proposed source(s) for input data. Propose a timetable for results submittal, review, and revision.	Approve/disapprove the method in the context of the emissions budgeting and source modeling used to demonstrate NAAQS attainment.	The air agency and airport operator can finalize accordance on how to inventory airport sources, how to report the results, and how to arrange future coordination through the remainder of the SIP development process.
Results Submittal and Documentation	Submit all emissions inventory results, data, and supporting documentation for agency review and incorporation. Ensure the documentation is of sufficient detail to facilitate future use, and yet concise enough and formatted in a manner that supports easy inclusion into the SIP document.	Review and if necessary request revisions to the inventory. Provide airport preparers with guidance on how to format results, data, and documentation for the purposes of modeling and reporting.	Accurate airport emissions data are adopted into the SIP, along with robust and transparent documentation for ease of future usage and reference.

For example, in numerous instances, airport emissions were indistinguishable in the SIP's overall emissions budgets or were consolidated within the broad mobile source category with numerous other nonroad sources. In other cases, where airport-related emissions were identified, it was unclear which airports or airport sources were explicitly included. This absence of specificity in some SIPs and lack of clarity in others rendered the subsequent identification of airport-related emissions in the SIP difficult and uncertain.

Often questions arise about how and when to coordinate on SIPs in a manner that will be of assistance to the regulatory agency but also address the needs of the airport operator. The presence and accuracy of this information becomes of paramount importance when a federally supported action is planned at an airport because before such action can be approved, it must be shown to conform to the SIP under the General Conformity Rule (see Chapter 2).

Therefore, with the aim of ensuring that airport emissions are properly represented and accounted for in SIPs, Table 5-2 and this section provides suggestions on how airport operators and regulatory agencies can improve their coordination by following these best practices.

5.2.2 Introductory Meetings

As a means of establishing a mutual understanding of the roles and responsibilities of airport operators and regulatory agencies as they generally pertain to managing aviation and air quality, respectively, introductory meetings can be beneficial. Broadly viewed as "meet-and-greets" or "ice-breakers," these meetings are aimed at introducing airport and agency staffs to each other and providing a forum for sharing information that would be instructive to both parties in the airport operation and SIP Development Processes.

Idea: Airport/agency introductory meetings are the most appropriate and advantageous in the early phases of the SIP Development Process, but can occur anytime during the process.

For example, state and local air quality regulatory agency representatives may describe their involvement in the SIP Development Process in terms of their designated responsibilities and required contributions. The principal objectives of the SIP, as well as any relevant challenges related to aviation in attaining the NAAQS, might also be discussed. For the airport representatives, this encounter can provide an opportunity to better identify and characterize the various sources of airport-related emissions, discuss concepts related to the boundaries and ownerships of these sources, as well as to reveal pertinent information to the regulatory agencies about airport operations that may be useful (e.g., the replacement of fossil-fueled GSE fleet with alternative fuel vehicles or electric vehicles).

Building on Airport/Agency Relationships

Airport environmental staff often has established relationships with air quality agency staff that issue airport-related stationary source operating permits but may not have contacts with regulatory staff involved with SIP-related emissions inventories. Thus, the SIP introductory meetings between airport and agency personnel represent opportunities to expand and strengthen these existing relationships.

In both cases, the overriding intent of this initial coordination is essentially three-fold: (1) to be better informed of how airport-related emissions can be appropriately and accurately accounted for in the SIP, (2) identify pathways and options on how this objective can be most effectively accomplished, and (3) discuss the general framework of how emissions sources should be treated in the SIP inventory based on the parties' mutual understanding of how the airport operates.

5.2.3 Topics for Discussion

During the introductory meeting, or as part of subsequent airport/agency coordination, there are a number of topics that are considered

Table 5-3. Airport/agency coordination topics.

Topics for Discussion	Why It Matters
Airports	
Airport inclusion and identification convention.	Nonattainment/maintenance areas often contain more than one airport. The approach to accounting for each airport's emissions in the SIP need to be established.
Emissions Source Categories	
SIP versus airport emissions source categories.	SIP emissions inventories either encompass airport emissions under the single category of airports or are subdivided by aircraft, APUs, and GSE. The preferred reporting convention needs to be understood and agreeable to both stakeholders.
Airports Emissions Source Ownership and Control	
Sources of emissions that are under airport operator's jurisdiction or control.	Airports constitute an assemblage of emissions sources (e.g., aircraft, GSE, etc.) that are owned or operated by different entities (e.g., airlines, cargo carriers, fixed-based operators, etc.). The availability of emissions inventory input data is largely dependent on the ability of these entities to supply the necessary information.
Timeframes	
SIP milestones versus airport planning timeframes.	SIP attainment schedules are usually based on 3-year milestones and seldom extend more than 10 years in the future. Airport development plans are often broken down into 5-year increments and cover a 20-year planning horizon.
Other Emissions Sources	
A variety of airport-related sources of emissions are accounted elsewhere in the SIP.	Stationary sources (e.g., boilers, generators, etc.), on-site motor vehicles, and construction activities are often included in airport emissions inventories.
Emissions Inventory Reporting	
Airport emissions inventory results and supporting materials.	For accounting purposes and ease of verification, SIPs should contain data and information that reveals how the airport emissions were computed.
Supplemental information and data.	In some cases, the emissions inventory computer files as well as the temporal and spatial characteristics of the airport's emissions are required by the agency.

to be central to ensuring that airport emissions are properly accounted for in SIPs. Listed in Table 5-3, these topics span a spectrum ranging from airport-related emissions source ownership to how the airport emissions will be reported in the SIP.

Addressing these topics can help to (1) reduce duplication of efforts between the airports and agencies, (2) avoid or minimize the underestimating or double counting of the airport's emissions, and (3) ensure that the airport emissions inventory is the most applicable and purposeful it can be.

5.2.4 Airport Emissions Inventory Protocol

Another useful means of enhancing airport/agency coordination can be the development and application of an Emissions Inventory Protocol—particularly in cases where the airport emissions inventory is complex (i.e., Intermediate or Advanced Approaches). The purpose of the protocol is to document the scope of the emissions inventory; identify which airports, sources, and pollutants will be included; and clarify subjects of prior uncertainty. Once the protocol document has been finalized, airport and agency personnel can formulate a Memorandum of Understanding, or otherwise agree that the approach is acceptable.

5.2.5 Dispersion Modeling

Although it is rare for airports to participate in air quality dispersion modeling efforts undertaken by state/local agencies preparing the SIP, occasions may arise in which airport involvement is advantageous. In this regard, airport staff may provide the agencies with airport-specific temporal and spatial data for the airport's emissions sources as input to regional air quality models including the Urban Airshed Model and Community Multiscale Air Quality modeling systems (see Chapter 4).

5.3 Documentation and Reporting

The lack of adequate documentation regarding airport emissions inventories was previously identified in Chapter 1 as a significant deficiency of many existing SIPs. As a practical matter, the documentation for an SIP emissions inventory depends on the detail level of the inventory. For the purposes of airport emissions inventories, it is generally recommended that the documentation contain a moderate-to-high level of airport-specific data, including the results, emissions models or databases used, input data and assumptions, and QA/QC confirmation. Chapter 4 provides further details and examples of how to conduct this documentation and reporting.

Reference: Section 4.9 of Chapter 4 provides further recommendations, details, and examples of how to prepare documentation in support of airport emissions inventories for SIPs.

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Appendixes A through E

The following appendixes are available on the attached CD-ROM and from the TRB website (http://www.trb.org; search for "Guidebook for Preparing Airport Emissions Inventories for State Implementation Plans"):

Appendix A	Summary of SIP Review Research
Appendix B	Airport-Related Data Sources
Appendix C	Airport Emissions Estimator Tool
Appendix D	Case Studies
Appendix E	Assessment of the "TAF+10" Formula

Glossary

Air Carrier: An operator (e.g., airline) in the commercial system of air transportation consisting of aircraft that hold certificates of Public Convenience and Necessity issued by the department of transportation to conduct scheduled or nonscheduled flights within the country or abroad.

Air Pollution: One or more chemicals or substances in high enough concentrations in the air to harm humans, other animals, vegetation, or materials. Such chemicals or physical conditions (such as excess heat or noise) are called air pollutants.

Airport Operators: This group mainly consists of airport owners/operators and their representatives (e.g., consultants and contractors). Among the various emission source categories typically included in SIPs, airports characteristically encompass a unique assembly of mobile sources including aircraft, APUs, and GSE. As such, airport operators are well incentivized and uniquely positioned to ensure that these emissions are properly represented and accounted for in SIPs.

Air Traffic Activity Data System (ATADS): The ATADS contains the official National Airspace System (NAS) air traffic operations data available for public release.

Aviation System Performance Metrics (ASPM): The ASPM is an FAA online access system that provides detailed data on Instrument Flight Rules (IFR) flights to and from the ASPM airports (currently 77); and all flights by the ASPM carriers (currently 22), including flights by those carriers to international and domestic non-ASPM airports. ASPM also includes airport weather, runway configuration, and arrival and departure rates. Additional details can be found at http://aspmhelp.faa.gov/index.php/ASPM_System_Overview.

Attainment Area: Any area that meets the NAAQS established for the criteria air pollutants

Auxiliary Power Units (APUs): APUs are small turbine engines used by many commercial jet aircraft to start the main engines; provide electrical power to aircraft radios, lights, and other equipment; and to power the onboard air conditioning (heating and cooling) system.

Aviation Gasoline: All special grades of gasoline for use in aviation reciprocating engines, as cited in ASTM Specification D 910. Includes all refinery products within the gasoline range that are to be marketed straight or in blends as aviation gasoline without further processing (any refinery operation except mechanical blending). Also included are finished components in the gasoline range, which will be used for blending or compounding into aviation gasoline.

Carbon Monoxide (CO): CO is a product of incomplete combustion, is relatively non-reactive, and is mostly associated with motor vehicle traffic. High CO concentrations develop primarily during winter when periods of light winds interact with ground level temperature inversions (typically from the evening through early morning) and reduce the dispersal of vehicle emissions. Motor vehicles also exhibit increased CO emission rates at low air temperatures. When inhaled at high concentrations, CO combines with hemoglobin in the blood and reduces its

oxygen-carrying capacity, resulting in reduced oxygen reaching the brain, heart, and other body tissues. This condition is especially critical for people with cardiovascular diseases, chronic lung disease, or anemia.

Criteria Pollutant: A pollutant determined to be hazardous to human health and regulated under the U.S. EPA's National Ambient Air Quality Standards. The 1970 amendments to the Clean Air Act require the U.S. EPA to describe the health and welfare impacts of a pollutant as the "criteria" for inclusion in the regulatory regime. The standards are designed to protect both the public health—known as *primary standards*—and welfare (or the natural environment)—known as *secondary standards*—when applied to ambient (i.e., outdoor) conditions. Criteria pollutants are carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOCs), sulfur oxides (SO_x), particulate matter (PM)equal to or less than 10 micrometers (coarse particulates or PM_{10}), particulate matter equal to or less than 2.5 micrometers (fine particulates or $PM_{2.5}$), and lead (Pb).

Early Action Compacts: For areas with the potential of violating the NAAQS, the U.S. EPA allowed the states to develop and implement plans to ensure that the area met the NAAQS. The U.S. EPA in return deferred the designation of the area to nonattainment and the imposition of the nonattainment requirements on the area.

Emission Factor: The rate at which pollutants are emitted into the atmosphere by one source or a combination of sources.

Emissions Indices: A unique value for scaling emissions to activity data in terms of a standard rate of emissions per unit of activity (e.g., grams of pollutant emitted per aircraft operation).

Emissions: Releases of gases to the atmosphere (e.g., the release of carbon dioxide during fuel combustion). Emissions can be either intended or unintended releases.

Emissions and Dispersion Modeling System (EDMS): The EDMS is designed to assess the air quality impacts of airport emission sources, particularly aviation sources. In 1998, the FAA revised its policy on air quality modeling procedures to identify EDMS as the *required* model to perform air quality analyses for aviation sources instead of the *preferred* model. This revised policy ensures the consistency and quality of aviation analyses performed for the FAA. The FAA continues to enhance the model under the guidance of its government/industry advisory board to more effectively determine emission levels and concentrations generated by typical airport emission sources.

Emissions Inventory: A list of air pollutants emitted into the atmosphere of a community, state, nation, or the Earth, in amounts per some unit time (e.g., day or year) by type of source. An emission inventory has both political and scientific applications.

FAA T-1 Data: This database refers to information collected by the FAA and reported by the Bureau of Transportation Statistics concerning on-time arrival data for non-stop domestic flights by major air carriers, and provides such additional items as departure and arrival delays, origin and destination airports, flight numbers, scheduled and actual departure and arrival times, cancelled or diverted flights, taxi-out and taxi-in times, air time, and non-stop distance.

General Aviation: The portion of civil aviation that encompasses all facets of aviation except air carriers. It includes any air taxis, commuter air carriers, and air travel clubs that do not hold Certificates of Public Convenience and Necessity.

General Conformity *de minimis* thresholds: The minimum emission threshold for which a General Conformity Determination must be performed, for various criteria pollutants in various areas.

Ground Support Equipment (GSE): Equipment that services aircraft after arrival and before departure at an airport and also the vehicles that support the operation of the airport. The types

of GSE at airports include aircraft tugs, baggage tugs, deicers, fuel trucks, hydrant carts, catering trucks, cargo tractors, water trucks, lavatory trucks, cabin service, belt loaders, and cargo loaders.

Hydrocarbons: Substances containing only hydrogen and carbon. Fossil fuels are made up of hydrocarbons.

Jet Fuel: Includes both naphtha-type and kerosene-type fuels meeting standards for use in aircraft turbine engines. Although most jet fuel is used in aircraft, some is used for other purposes such as generating electricity.

Landing and Takeoff (LTO) Cycle: One aircraft LTO is equivalent to two aircraft operations (one landing and one takeoff). The standard LTO cycle begins when the aircraft crosses into the mixing zone as it approaches the airport on its descent from cruising altitude, lands, and taxis to the gate. The cycle continues as the aircraft taxis back out to the runway for takeoff and climbout as it heads out of the mixing zone and back up to cruising altitude. The five specific operating modes in a standard LTO are approach, taxi/idle-in, taxi/idle-out, takeoff, and climbout. Most aircraft go through this sequence during a complete standard operating cycle.

Maintenance Area: Any area that is in transition from formerly being a nonattainment area to an attainment area.

Mixing Height: The height of the completely mixed portion of atmosphere that begins at the Earth's surface and extends to a few thousand feet overhead where the atmosphere becomes fairly stable.

Mobile Source: A moving vehicle that emits pollutants. Such sources include airplanes, cars, trucks, and ground support equipment.

National Plan of Integrated Airport Systems (NPIAS): The NPIAS identifies nearly 3,400 existing and proposed airports that are significant to national air transportation and thus eligible to receive federal grants under the Airport Improvement Program.

Nitrogen Oxides (NO_x): Gases consisting of one molecule of nitrogen and varying numbers of oxygen molecules. Nitrogen oxides are produced, for example, by the combustion of fossil fuels in vehicles and electric power plants. In the atmosphere, nitrogen oxides can contribute to formation of photochemical ozone (smog), impair visibility, and have health consequences; they are considered pollutants.

Nitrogen Dioxide (NO_2): A pollutant that acts as a respiratory irritant. NO_2 is a major component of the group of gaseous nitrogen compounds commonly referred to as NO_x. A precursor to ozone formation, NO_x is produced by fuel combustion in motor vehicles, stationary sources used in industrial activities, ships, aircraft, and rail transit. Typically, NO_x emitted from fuel combustion is in the form of nitric oxide (NO) and NO_2. NO is often converted to NO_2 when it reacts with ozone or undergoes photochemical reactions in the atmosphere.

Nonattainment Area: Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the NAAQS.

Non-Methane Volatile Organic Compounds (NMVOCs): Organic compounds, other than methane, that participate in atmospheric photochemical reactions.

Ozone: A colorless gas with a pungent odor, having the molecular form of O_3, found in two layers of the atmosphere, the stratosphere and the troposphere. Ozone is a form of oxygen found naturally in the stratosphere that provides a protective layer shielding the Earth from ultraviolet radiation's harmful health effects on humans and the environment. In the troposphere, ozone is a chemical oxidant and major component of photochemical smog. Ozone can seriously affect the human respiratory system.

Ozone Precursors: Chemical compounds, such as carbon monoxide, methane, non-methane hydrocarbons, and nitrogen oxides that, in the presence of solar radiation, react with other chemical compounds to form ozone, mainly in the troposphere.

Particulate Matter ($PM_{10/2.5}$): Solid particles or liquid droplets suspended or carried in the air. Particulate matter equal to or less than 10 microns in diameter (PM_{10}) and particulate matter equal to or less than 2.5 microns in diameter ($PM_{2.5}$) represent fractions of particulate matter that can penetrate deeply into the respiratory system and cause adverse health effects. Particulate matter in the atmosphere results from many kinds of dust- and fume-producing industrial and agricultural operations, fuel combustion, and atmospheric photochemical reactions.

Parts Per Million (ppm): Number of parts of a chemical found in one million parts of a particular gas, liquid, or solid.

Regulatory Agencies: This group includes state, regional, and/or local air quality regulatory and planning agencies involved in preparing and updating SIPs. In this role, their work involves the preparation of emission inventories for all emission sources within the nonattainment and maintenance area (including airports), determining the appropriate amounts of emissions allowable regionally, and formulating the necessary emission reduction strategies and milestones to meet the NAAQS within prescribed timeframes.

State Implementation Plan (SIP): Under the federal CAA states are required to submit an SIP to the U.S. EPA for those counties or regions where air quality conditions do not meet one or more of the NAAQS. The SIP describes how each nonattainment region will attain and maintain the NAAQS. SIPs typically include emission inventories, air quality monitoring data, emission reduction goals and objectives, timetables, emission control measures and strategies considered necessary for nonattainment and maintenance areas to meet the NAAQS, and enforcement mechanisms.

Sulfur Dioxide (SO_2): A compound composed of one sulfur and two oxygen molecules. Sulfur dioxide emitted into the atmosphere through natural and anthropogenic processes is changed in a complex series of chemical reactions in the atmosphere to sulfate aerosols. These aerosols are believed to result in negative radiative forcing (i.e., tending to cool the Earth's surface) and do result in acid deposition (e.g., acid rain).

Terminal Area Forecast (TAF): The TAF system is the official forecast of aviation activity at FAA facilities. These forecasts are prepared to meet the budget and planning needs of the FAA and provide information for use by state and local authorities, the aviation industry, and the public.

Volatile Organic Compounds (VOCs): Organic compounds that evaporate readily into the atmosphere at normal temperatures. VOCs contribute significantly to photochemical smog production and certain health problems.

Abbreviations and Acronyms

ACRP	Airport Cooperative Research Program
AEDT	Aviation Environmental Design Tool
AEM	Airport Emission Model
AGL	Above Ground Level
AIP	Airport Improvement Program
AMR	Airport Master Record
ANOMS	Airport Noise and Operations Monitoring System
APU	Auxiliary Power Units
ASPM	Aviation System Performance Metrics
ATADS	Air Traffic Activity Data System
ATL	Hartsfield-Jackson Atlanta International Airport
BID	Block Island State Airport
BLS	Bureau of Labor Statistics
BNA	Nashville International Airport
BTS	Bureau of Transportation Statistics
CAA	Clean Air Act
CAIR	Clean Air Interstate Rule
CARB	California Air Resources Board
CBSA	Core Based Statistical Areas
CEIDARS	California Emission Inventory Development and Reporting System
CEFS	California's Emission Forecasting and Planning Inventory System
CERR	Consolidated Emissions Reporting Rule
CO	Carbon Monoxide
DEN	Denver International Airport
EDMS	Emissions and Dispersion Modeling System
EEA	Energy and Environmental Analysis
EGAS	Economic Growth Analysis System
EIIP	Emission Inventory Improvement Program
ETMS	Enhanced Traffic Management System
FAA	Federal Aviation Administration
FAEED	Federal Aviation Administration Aircraft Engine Emissions Database
FAR	Federal Aviation Regulation
FIP	Federal Implementation Plan
FOA	Fixed Order Approximation
GA	General Aviation
GPU	Ground Power Units
GSE	Ground Support Equipment
ICAO	International Civil Aviation Organization

IPP	Inventory Preparation Plan
INM	Integrated Noise Model
LAS	Las Vegas McCarran International Airport
LTO	Landing and Takeoff Cycle
MAG	Maricopa Association of Governments
MANE-VU	Mid-Atlantic/Northeast Visibility Union
MPO	Metropolitan Planning Organizations
NAAQS	National Ambient Air Quality Standard
NCDC	National Climatic Data Center
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act
NMHC	Non-Methane Hydrocarbons
NO_2	Nitrogen Dioxide
NPIAS	National Plan of Integrated Airport Systems
O_3	Ozone
PARTNER	Partnership for Air Transportation Noise and Emission Reduction
Pb	Lead
PCA	Pre-Conditioned Air
PM_{10}	Particulate Matter Equal to or Less Than 10 Micrometers (or Coarse Particulates)
$PM_{2.5}$	Particulate Matter Equal to or Less Than 2.5 Micrometers (or Fine Particulates)
ppm	Parts per Million
PSP	Palm Springs Airport
RFP	Rate of Further Progress
ROG	Reactive Organic Gases
SASP	State Airport System Plan
SEA	Seattle-Tacoma International Airport
SIMMOD	Airspace and Airport Simulation Model
SIP	State Implementation Plan
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	Sulfur Dioxide
TAAM	Total Airport and Airspace Modeler
TAF	Terminal Area Forecast
TAP	Technical Analysis Protocol
THC	Total Hydrocarbons
TRB	Transportation Research Board
VALE	Voluntary Airport Low Emissions Program
VISTA	Visibility Improvement State and Tribal Association
VOC	Volatile Organic Compound
U.S. EPA	United States Environmental Protection Agency
$\mu g/m^3$	Micrograms per Cubic Meter

Frequently Asked Questions

The following list of frequently asked questions and answers is intended to address topics that are expected to arise when reviewing or using this *Guidebook.* They are developed with the two primary stakeholders in mind: airport operators and air quality regulatory agencies.

1. What is a State Implementation Plan (SIP)?

Answer: In simple terms, an SIP is a state's plan for meeting the National Ambient Air Quality Standards (NAAQS). Under the federal Clean Air Act (CAA) states are required to submit an SIP to the U.S. Environmental Protection Agency (U.S. EPA) for those counties or regions where air quality conditions do not meet one or more of the NAAQS. The SIP describes how each non-attainment region will attain and maintain the NAAQS. SIPs typically include emission inventories, air quality monitoring data, emission reduction goals and objectives, timetables, emission control measures and strategies considered necessary for nonattainment and maintenance areas to meet the NAAQS, and enforcement mechanisms.

2. What are attainment, nonattainment and maintenance areas?

Answer: Areas that meet the NAAQS are designated as *attainment;* areas that do not meet the NAAQS are *nonattainment;* and areas that are in transition from nonattainment to attainment are designated as *maintenance* (or *attainment/maintenance*).

3. How do I determine if the airport is located in a nonattainment or maintenance area?

Answer: The attainment status for a specific region can be determined by contacting the state or local air quality regulatory agency in the areas of interest. This information is also posted on the U.S. EPA *Green Book* at website (http://www.epa.gov/oar/oaqps/greenbk/index.html).

4. Who prepares the SIP?

Answer: SIPs are developed by state air quality regulatory agencies (with inputs from regional and local agencies) and submitted to the U.S. EPA for review and approval.

5. Where do I obtain a copy of an SIP?

Answer: The SIP should be available by contacting the state or local air quality regulatory agency in the areas of interest. Importantly, the information pertaining to airport-related emissions may be contained in an appendix to the SIP or may require contact with the air quality regulatory agency to determine the information for a specific airport.

6. Why should I care about the SIP and the airport emissions?

Answer: Before the FAA can approve, fund, or permit a federal project or action occurring in a nonattainment or maintenance area, the FAA must first show that the project/action conforms to the SIP. If the action is not on the FAA's Presumed-to-Conform list, it must meet the

requirements of the CAA General Conformity Rule. This can be accomplished by demonstrating that (1) project/action-related emissions are below the applicable *de minimis* levels, (2) the emissions are accounted for in the SIP, (3) the emissions can be reduced to below *de minimis* levels, and/or (4) the SIP can be amended to include the project-related emissions.

The easiest and most desirable method of demonstrating that a project "conforms" is to demonstrate that the airport's and the project-related emissions are accounted for in the SIP. This can be accomplished by following the recommendations and procedures contained in this *Guidebook.*

7. What are General Conformity *de minimis* thresholds?

Answer: The minimum emission threshold for which a conformity determination must be performed for various criteria pollutants in various areas. The information is summarized as follows:

Pollutant	Area Type	Tons/Year
Ozone (VOC or NO_x)	Serious nonattainment	50
	Severe nonattainment	25
	Extreme nonattainment	10
	Other areas outside an ozone transport region	100
Ozone (NO_x)	Marginal and moderate nonattainment inside an ozone transport region	100
	Maintenance	100
Ozone (VOC)	Marginal and moderate nonattainment inside an ozone transport region	50
	Maintenance within an ozone transport region	50
	Maintenance outside an ozone transport region	100
CO, SO_2 and NO_2	All nonattainment and maintenance	100
PM_{10} and $PM_{2.5}$	Serious nonattainment	70
	Moderate nonattainment and maintenance	100
Lead (Pb)	All nonattainment and maintenance	25

8. How can airports participate in the SIP development process?

Answer: Airport operators can participate in the SIP development process in a number of ways. The optimal way is to prepare an emission inventory for the airport and submit it to the agency preparing the SIP. However, airport operators should first coordinate with the air agencies responsible for the SIP to determine if there are specific local requirements that could influence the scope and format of the emission inventory. For instance, in locations that are nonattainment for ozone (O_3), state/local air agencies typically prepare an emission inventory assuming summer conditions (i.e., climatic conditions that exist in summer months). For locations that are nonattainment for CO, state/local air quality regulatory agencies often use winter weather conditions as the basis for their emission inventory. This coordination will ensure that the air agency has the information in a form that can be used in the SIP.

9. What sources of airport emissions can be documented in a SIP?

Answer: As discussed in Chapter 4 of this *Guidebook,* the three principal sources of emission that should be addressed in the airport emission inventory are aircraft engines, APUs, and GSE. For fuel storage and transfer facilities and on-site motor vehicle traffic, contact the agency that prepares the SIP to determine if these emissions should be included in the airport emission inventory. It is generally accepted that stationary sources located on property owned and controlled by the airport operator have operating permits and therefore are accounted

for in the SIP and do not need to be included in the airport emission inventory. Off-site airport-related motor vehicle traffic is assumed to be accounted for as part of the area-wide surface transportation emissions of the SIP and should not be included in the airport emission inventory.

Construction-related emissions are subject to the CAA General Conformity Rule but are not addressed in this *Guidebook*.

10. Who should prepare an airport emission inventory for an SIP?

Answer: The airport operator is in the best position to prepare the emission inventory as it is likely to have the most accurate and up-to-date information. The agency preparing the SIP can also prepare the airport emission inventory. In both cases, there should be coordination between both parties (see **Chapter 5** for Coordination Best Practices).

11. The Guidebook describes three approaches to preparing an airport emission inventory. Which approach should I use to prepare an airport emission inventory?

Answer: The selection of an approach recommended by this *Guidebook* should be based on a number of factors including the size of the airport, the level of aircraft activity, the availability of data, and the level of accuracy desired. See **Chapter 3** for guidance on how to evaluate and select an approach.

12. Where do I obtain the necessary information and data to prepare an airport emissions inventory?

Answer: The information and data can be obtained from various sources including the airport owner/operator, the FAA and/or previous studies. See **Chapter 4** and **Appendix B** for guidance.

13. When or how often should I prepare an airport emission inventory for an SIP?

Answer: The airport emission inventory should be prepared and/or updated when (1) a new SIP is being prepared, (2) when an existing SIP is being updated or revised, or (3) as part of a General Conformity Determination.

14. What are criteria air pollutants?

Answer: The U.S. EPA defines criteria pollutants as ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter (PM_{10} and $PM_{2.5}$), and lead. The term "criteria air pollutants" is derived from the requirement that the U.S. EPA must describe the characteristics and potential health and welfare affects of these air pollutants. Periodically the U.S. EPA reviews new scientific data and may propose revisions to the NAAQS as a result.

15. What happens when my airport inventory exceeds the inventory in the SIP?

Answer: There are several issues associated with the total airport-related emissions exceeding the allocation in the SIP inventory. First, the state and airport should understand why the emissions are greater than anticipated. This could be because activity at the airport was not accurately portrayed in the SIP or because activity is greater than reflected in the SIP. If this condition arises, airports and the regulatory agency should examine the ability to absorb the portion of emissions in other portions of the inventory that may be understated. If that is not possible, and the overage was to result in the region exceeding its emissions allocation, the airport might need to identify ways to reduce emissions. Finally, if the airport's emissions exceeded that within the SIP for conformity purposes, the General Conformity Rule identifies several ways for demonstrating conformity (see FAQ #6).

16. What authority does the airport operator have in controlling emissions? Can an airport require measures such as single engine taxiing?

Answer: The airport operator has limited ability to control emissions at the facility. The majority of the emissions come from aircraft and those emissions are governed by ICAO standards. Most of the equipment at the airport is operated by either the aircraft operators or a third-party contractor and is not under the direct control of the airport. The airport can require use of measures such as single engine taxiing and can provide gate power to reduce emissions.

17. Where can I obtain information on the type and number of aircraft landing and takeoff from the airport?

Answer: Aircraft operational data may be obtained from recent airport studies such as Master Plans, FAR Part 150 Studies, environmental planning documents, as well as ATADS, TAF, and other databases maintained by the BTS that provide what are referred to as Form 41, Schedules T100 and T100(f) data for air carriers.

18. Where can I obtain information about the future plans at the airport including projected changes in the aircraft fleet mix?

Answer: Master Plans, FAR Part 150 Studies, and NEPA/California Environmental Quality Act (CEQA) documents typically include descriptions of future plans at airports including projected changes in aircraft operations and fleet mix.

19. Why do the aviation emissions need to be subdivided in the SIP?

Answer: Airports receive funding and must receive approval for many actions from the FAA at the airport. Thus, the airport is subject to U.S. EPA General Conformity requirements. Specifically identifying airport emissions in the SIP facilitates the conformity reviews.

20. What type of airport actions require FAA approval?

Answer: FAA actions range from (but are not limited to) airport funding programs, Airport Layout Plan approvals reflecting a wide assortment of airport improvement projects and actions. All Federal actions require a demonstration of conformity with an applicable SIP unless specifically exempt. The FAA was among the first federal agencies to adopt a Presumed-to-Conform list of actions. These include (but are not limited to) airport safety and security projects, airport navaids, signage and lighting systems, terminal upgrades, and alternative fuel vehicle programs.

21. What models and emission factors were used to develop the *Airport Emissions Estimator Tool*?

Answer: This *Guidebook* relied upon the EDMS, ICAO emission factors, JP Fleet database, and default assumptions such as time-in-mode, APU and GSE assignments and operating times to develop the *Airport Emissions Estimator Tool.*

22. How conservative are the estimated emissions from the Basic Approach calculations?

Answer: For large/medium/small commercial-hub airports, the Basic Approach overestimates total emissions by up to three times for THC, CO, NO_x, and SO_x and up to four times for $PM_{10/2.5}$ when compared to the use of EDMS. These differences would translate into significant amounts of overestimated emissions (e.g., 4,000 tons of CO and 1,345 tons of NO_x) for this group of airports within a particular region.

For non-commercial hubs and GA airports, the *Airport Emissions Estimator Tool* also overestimates emissions (again, compared to the use of EDMS). However, the order of magnitude of the increase is much less for these types of facilities. Use of the *Emissions Estimator Tool* would

result in emissions estimates for THC, CO, NO_x, and SO_x that are four times higher than EDMS while emissions of $PM_{10/2.5}$ would be 15 times higher. While these values, especially for $PM_{10/2.5}$ seem great, because the emission totals for these airports are relatively small, the overestimation is also relatively small (e.g., use of the *Tool* overestimates NO_x emissions by 25 tons).

23. When should an airport be required to use an Intermediate or Advanced Approach?

Answer: It is suggested that large-, medium-, small-commercial-hub airports and non-commercial-hub and GA airports greater than 100,000 operations use the Intermediate or Advanced Approaches. Additional considerations such as degree of nonattainment, pollutant(s) of concern, future airport improvement plans, data availability, and others should also be taken into account when choosing an approach.

24. How will the replacement of EDMS with the Airport Environmental Design Tool (AEDT) affect the use of the *Guidebook*?

Answer: The eventual replacement of EDMS with the AEDT should not have any effect on the use of the *Guidebook*. However, the *Airport Emissions Estimator Tool* was prepared using EDMS so its results could differ when compared to results produced by AEDT.

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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MR. SCOTT BENNETT
ARKANSAS STATE HIGHWAY AND TRANSPORTATION DEPARTMENT
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